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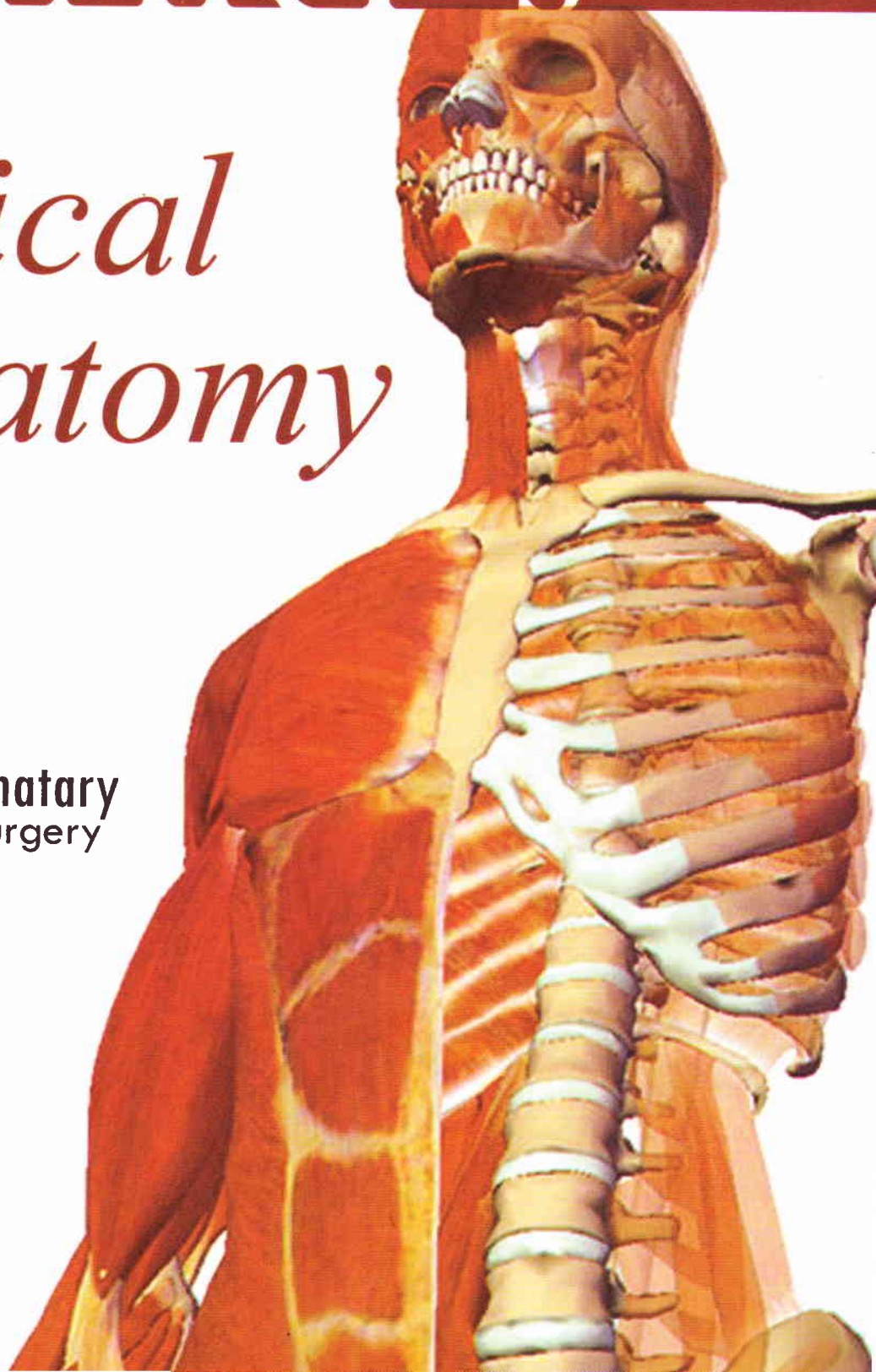

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MATARY SURGERY

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Dedication

Allah the all merciful, I beg Thee
To accept this effort
For the soul of my mother
She was your gift for me

Acknowledgement

The author wishes to acknowledge with gratitude

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Preface

This book provides an update for medical students who need to keep abreast of recent developments. I hope also it will be useful for those preparing for postgraduate examination.

This book is designed to provide a concise summary of anatomy, which medical students and others can use as study guide by itself or with readings in current textbooks, monographs, and reviews.

Summaries of relevant anatomical considerations are included in every chapter, taking into account that this book is written primarily for those who have some knowledge of anatomy and physiology.

The author is extremely grateful to all the contributors for the high standard of the new chapters, and hopes that you, the reader, will enjoy going through these pages as much as he had.

M. El-Matary

MATARY'S

Surgical Anatomy

First Edition

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Pelvis & Perineum 236

Lower Limb 264

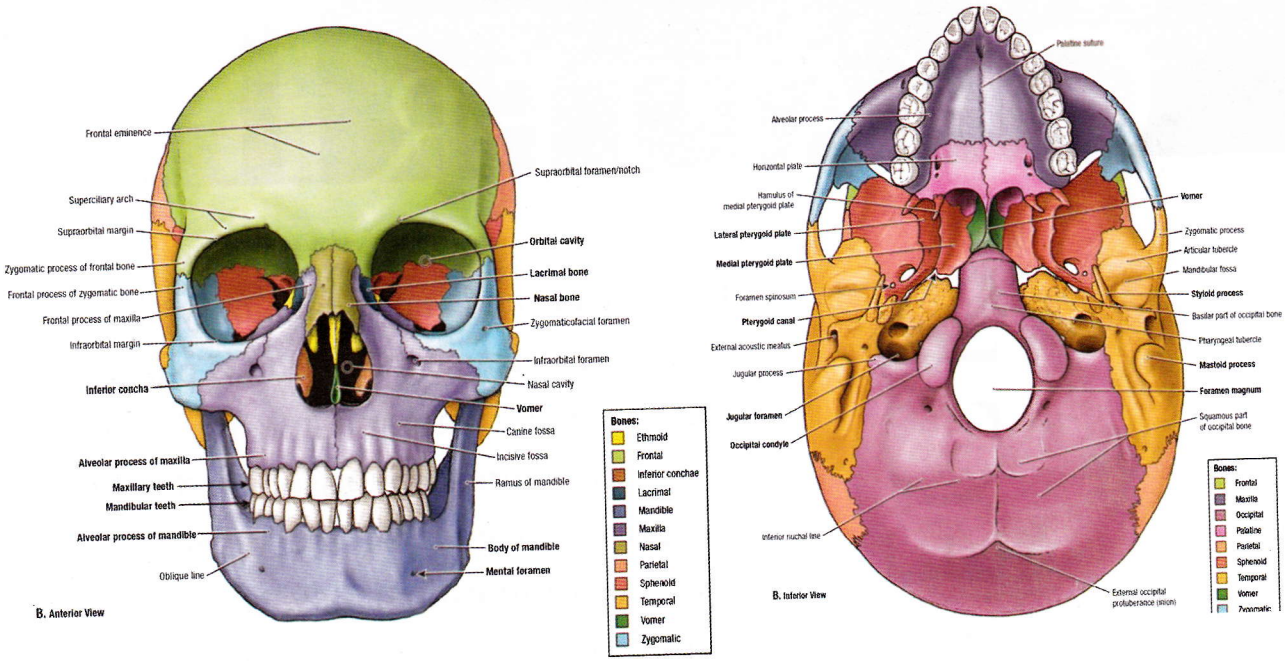
CHAPTER 1

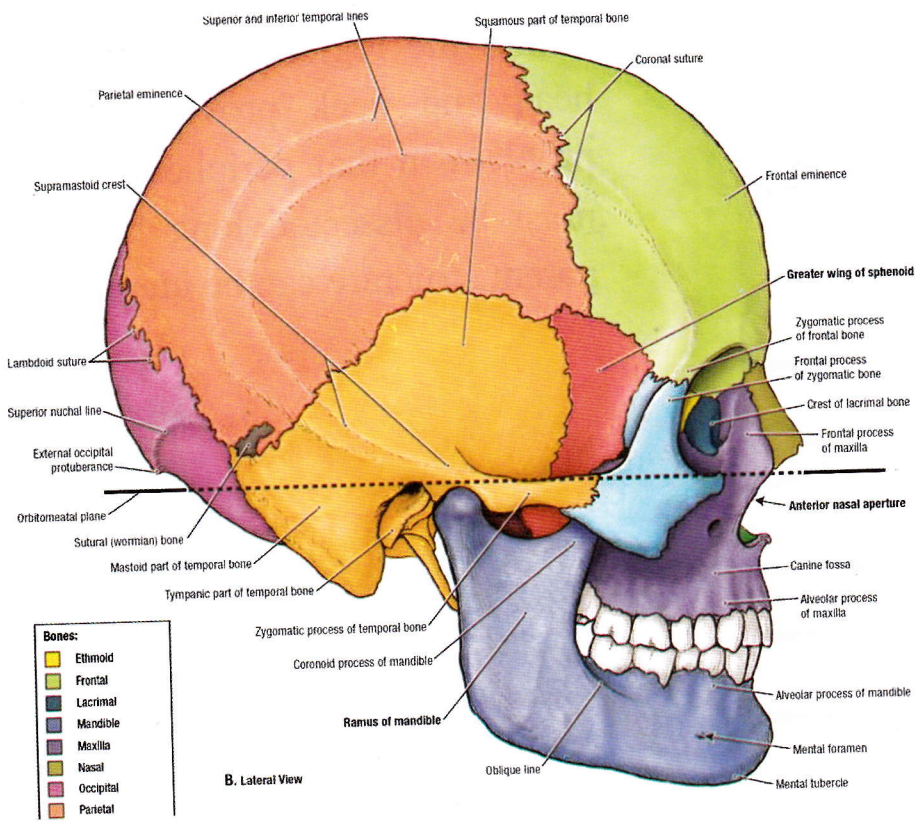
HEAD & NECK

The Head and neck anatomy is a challenge because the region is packed with small, important structures. These structures are associated with the proximal ends of the respiratory and gastrointestinal systems, the cranial nerves, and the organs of special sense, all of which are found within the region. Dissection of the head and neck provides a special problem in that peripheral structures must be dissected long before their parent structure can be identified.

Head & Neck

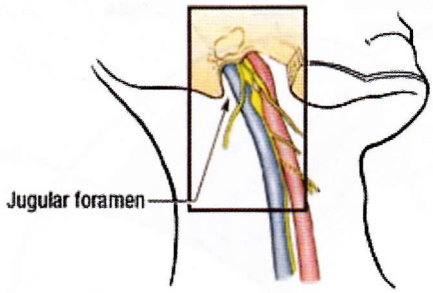
SKULL

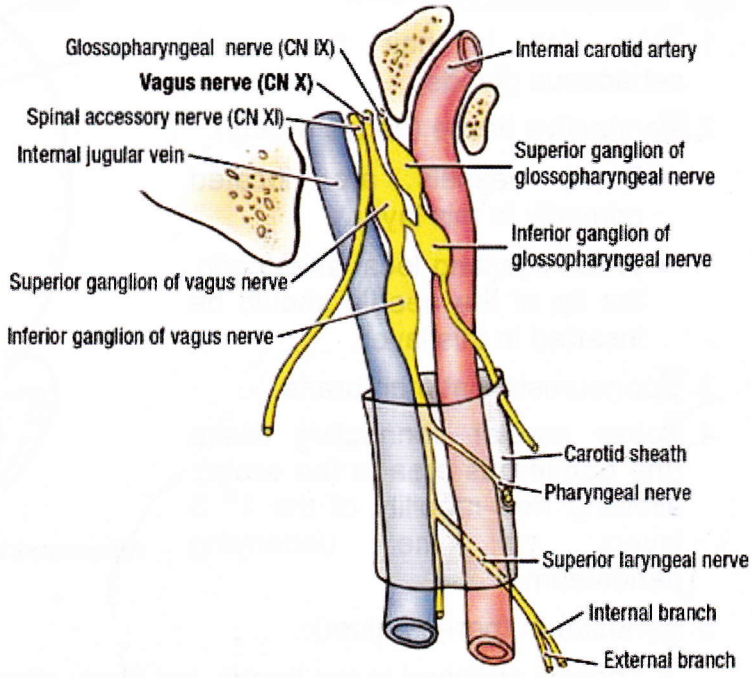




MCQ

Jugular foramen



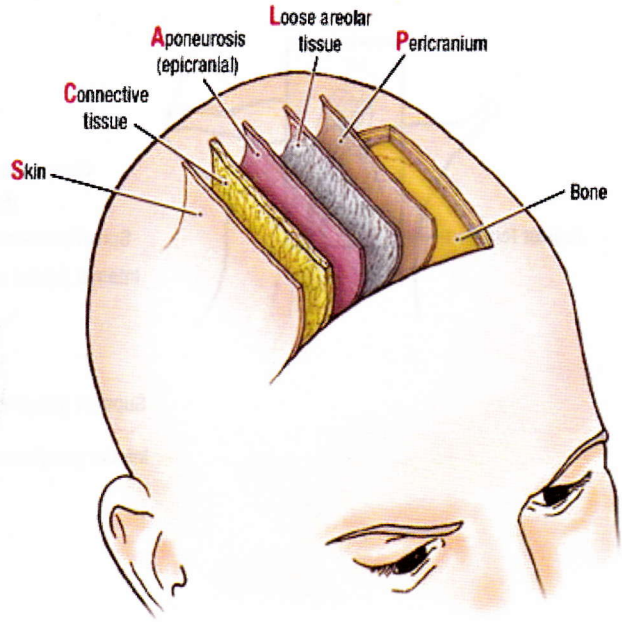


- ***The jugular foramen transmits:***
  - Internal jugular vein.
  - Inferior petrosal sinus.
  - Glosso-pharyngeal, vagus and accessory nerves (IX, X, XI).
- ***A tumor invading jugular foramen may lead to:***
  - Loss of taste sensation from posterior ⅓ of tongue.
  - Increased intra-cranial pressure.
  - Paralysis of muscles of soft palate.

- **The vagus lies most medial in the foramen.**
- **Glosso-pharyngeal nerve & inferior petrosal sinus exit from the anterior compartment of the foramen.**
- **Vagus & accessory nerves exit from the middle compartment.**
- **The sigmoid sinus exits from the jugular foramen to become the internal jugular vein.**
- **Tympanic branch of glosso-pharyngeal is called Jacobson nerve.**

THE SCALP

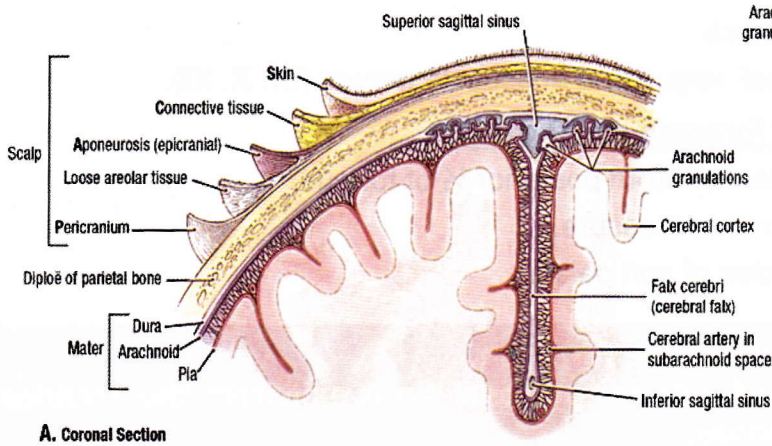
It is the soft tissue covering the skull vault.



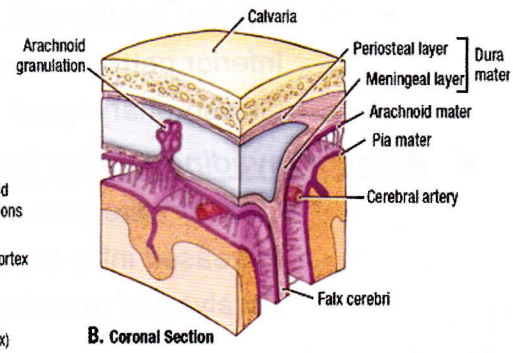
A. Superolateral view

MCQ Structure: *5 layers:*

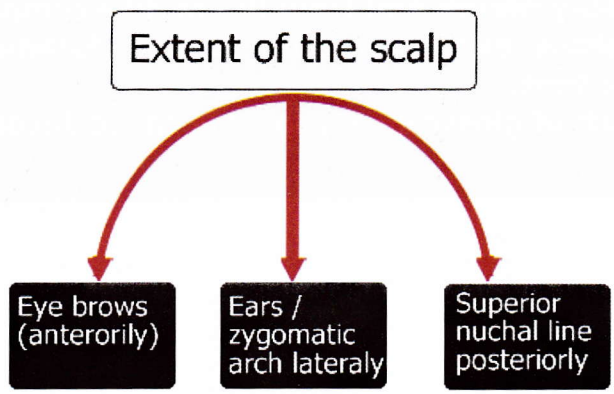
1. **S**kin: rich in hair follicles & sebaceous glands.
2. **C**onnective tissue (dense & fatty):
   - Blood vessels are located primarily in this layer.
   - When injecting local anesthetic, the tip of the needle should be inserted in this layer.
3. **A**poneurosis: flat membrane.
4. **L**oose areolar connective tissue (the dangerous area of the scalp): allowing free mobility of the 1st 3 layers on the underlying periosteum.
5. **P**eriosteum (peri-cranium):
   - Loosely attached to the bones, but firmly attached to suture lines.
   - Continuous with the outer layer of dura at the foramen magnum.



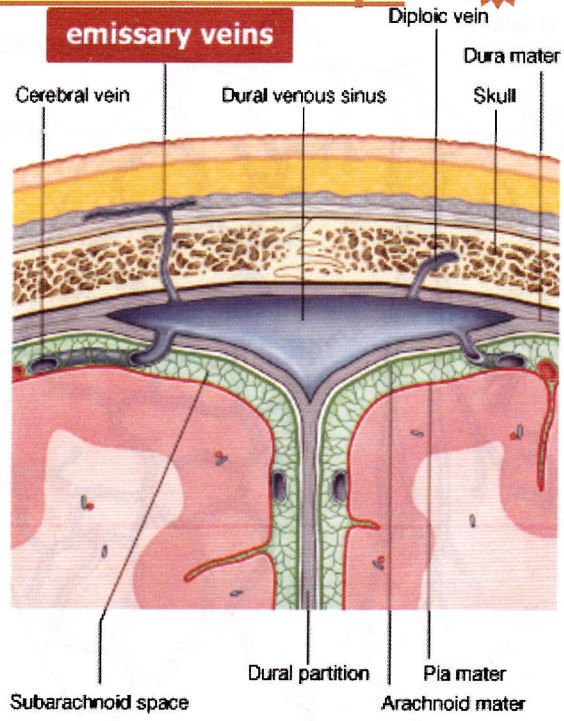
A. Coronal Section



B. Coronal Section



Dangerous area of the scalp: MCQ



- This is the loose areolar C.T. layer.
- It contains emissary veins
- which connect scalp veins to the dural sinuses.

Muscles of the scalp: MCQ

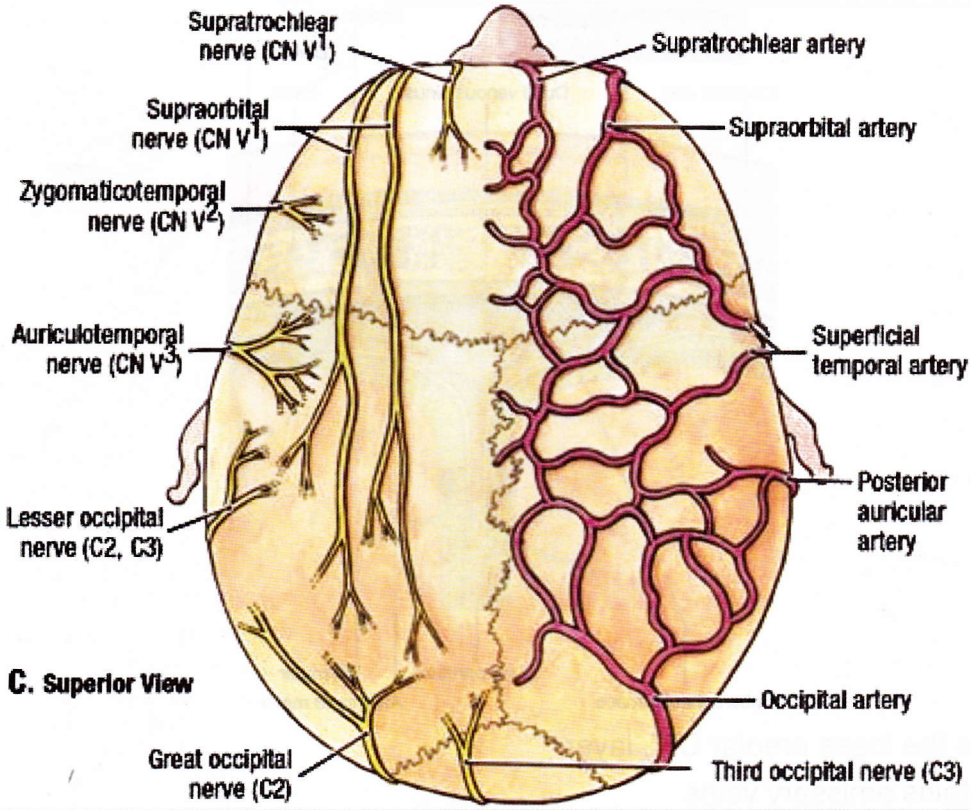
- **Occipitalis** is attached to the skull (at superior nuchal line).
- **Frontalis** is not attached to the skull.
- The muscles of the scalp are innervated by the **facial nerve**.

Lymphatic Drainage Of The Scalp: MCQ

- To the superficial circle of LNs around lower part of skull → deep LNs around carotid sheath.

Blood & sensory nerve supply of the scalp:

	Sensory n. supply of the scalp	Blood supply of scalp
In front of auricle	By trigeminal (5th) nerve 1.Supra-trochlear n. 2.Supra-orbital n. 3.Zygomatico-temporal n. 4.Auriclo-temporal n.	Branches of ophthalmic a. of the I.C.A: Supra-trochlear artery. Supra-orbital artery. Branches of E.C.A: Superficial temporal artery.
Behind the auricle	By cervical plexus 1.Great auricular n. 2.Lesser occipital n. 3.Greater occipital n. 4.3rd occipital n.	Branches of E.C.A: Posterior auricular artery. Occipital artery.



Venous drainage:

1- Supratrochlear vein
2- Supraorbital vein
} Unit to form facial vein at the medial orbital margin
3- Superficial temporal vein
4- Maxillary vein
5- Occipital vein

Points of Surgical Importance:

☒ **The 1st three layers of the scalp are intimately united & should be considered as one layer**

➢ **Surgical flaps of scalp during craniotomy:** MCQ

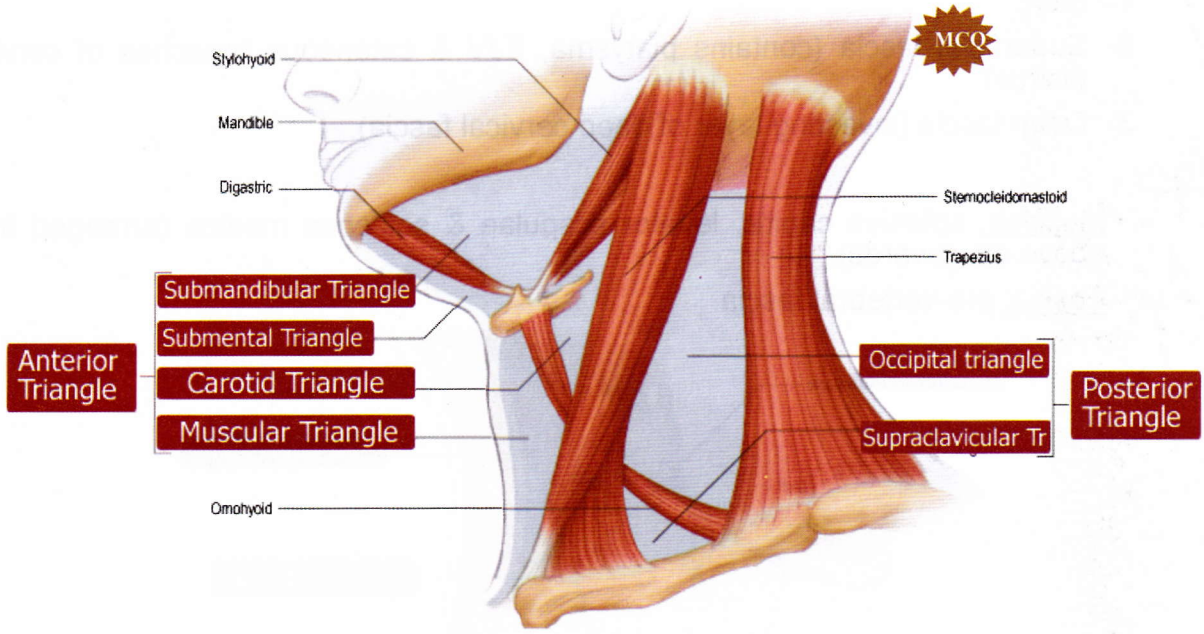
- Comprise the superficial 3 layers.
- They are turned downwards & not upwards *(nerves & vessels enter the scalp from periphery).*

➢ **Scalp hematoma:** MCQ

- ***Subcutaneous hematoma*** is small, tense & painful.
- ***Sub-aponeurotic collection of blood:*** may extend anteriorly to the eyelids forming black eye & posteriorly to superior nuchal line (attachment of occipito-frontalis).
- ***Sub-periosteal collection of blood:***
  - Is limited by attachment of the periosteum to the suture lines.
  - Feels like depressed fracture due to fibrin deposition at its periphery.

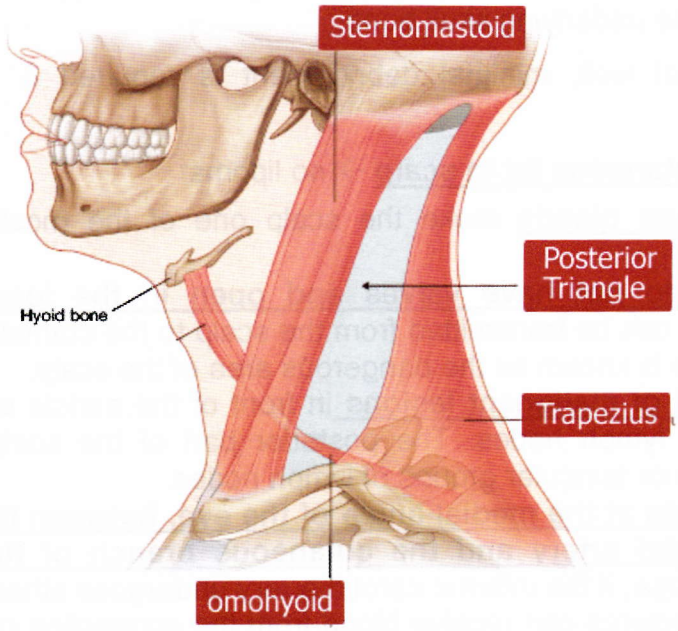
- **The scalp has very rich blood supply, this explains:**
  - Wounds of scalp bleed profusely. Bleeding can be stopped by compressing the scalp over the underlying skull bone.
  - Wounds heal well; minimal debridement is required & wound infection is uncommon.
- **There is no subcutaneous fat in scalp** → no lipoma.
- **Plentiful sebaceous glands** make the scalp one of the most common sites for sebaceous cysts.
- **Emissary veins do not have valves and open in the loose areolar tissue;** therefore, infection can be transmitted from the scalp to the cranial cavity. The layer of loose areolar tissue is known as the dangerous area of the scalp.
- **Metastatic spread of malignant lesions** in front of the auricle is to the parotid and cervical groups of lymph nodes. The posterior part of the scalp is drained to the occipital and posterior auricular groups of lymph nodes.
- **Anastomosis exists at the medial angle of the eye, between the facial branch of the external carotid artery and the cutaneous branch of the internal carotid artery.** During old age, if the internal carotid artery undergoes atherosclerotic changes, the intracranial structures can receive blood from the connection of the facial artery to the dorsal nasal branch of the ophthalmic artery.

TRIANGLES OF THE NECK



Each side of the neck is divided into anterior & posterior triangles by the sternomastoid muscle

POSTERIOR TRIANGLE



Boundaries:

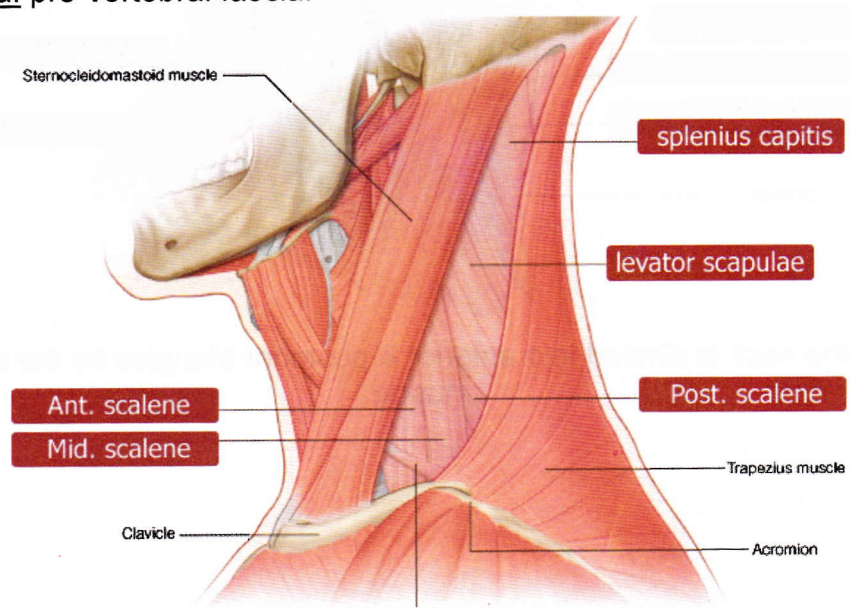
1- Anteriorly: posterior border of sternomastoid muscle.
2- Base: the clavicle (its middle ⅓).
3- Posteriorly: anterior border of trapezius muscle.

Roof:

1- Skin.
2- Superficial fascia (contains platysma, EJV & cutaneous branches of cervical plexus).
3- Deep fascia (investing layer of deep cervical fascia).

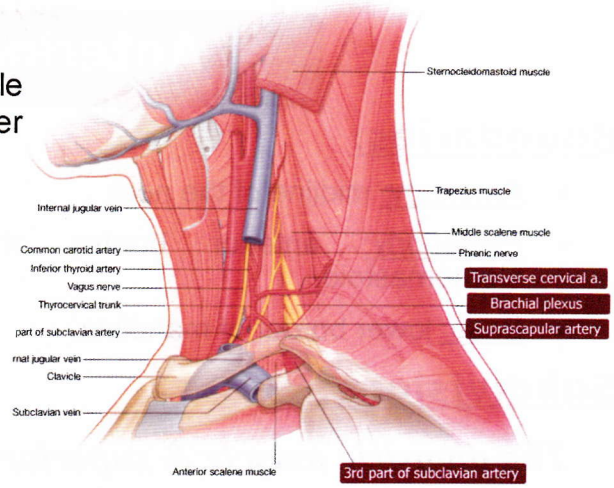
Floor:

- Muscles: splenius capitis, levator scapulae & scalenus medius (arranged from above downwards).
- Fascia: pre-vertebral fascia.



Contents:

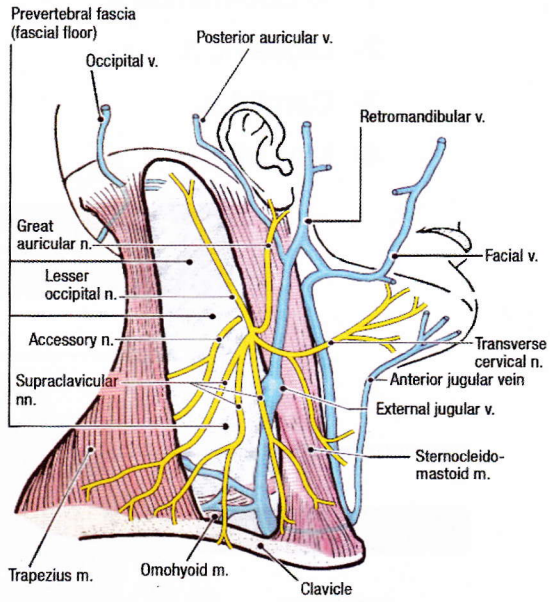
- **Muscles:** inferior belly of omohyoid muscle which divides the triangle into 2 smaller triangles *(occipital & supra-clavicular)*.

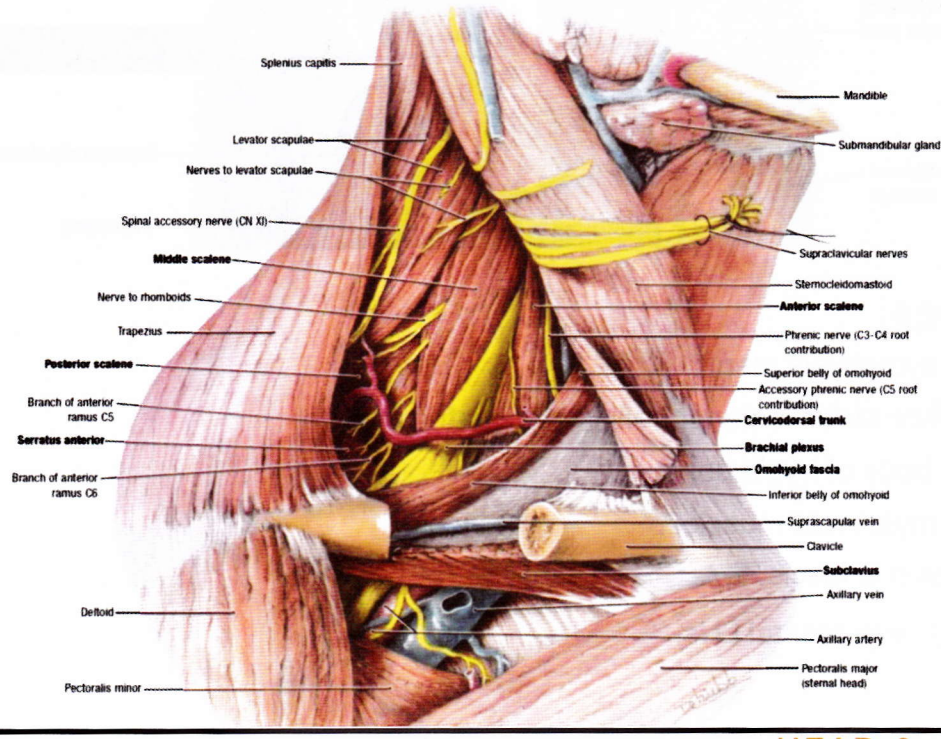


- **Arteries:**
  1- 3rd part of subclavian artery.
  2- Transverse cervical artery.
  3- Supra-scapular artery.
  4- 3rd part of occipital artery

} **Both are branches of the thyro-cervical trunk of 1st part of subclavian**

- **Veins:**
  1- Subclavian vein.
  2- Transverse cervical vein.
  3- Supra-scapular vein.
- **Lymph nodes:** supra-clavicular LNs.
- **Nerves:**
  - Accessory nerve.
  - Branches of the cervical plexus (muscular branches, a loop from C1 to hypoglossal nerve, inferior root of ansa cervicalis & phrenic nerve).
  - Brachial plexus (roots & trunks).

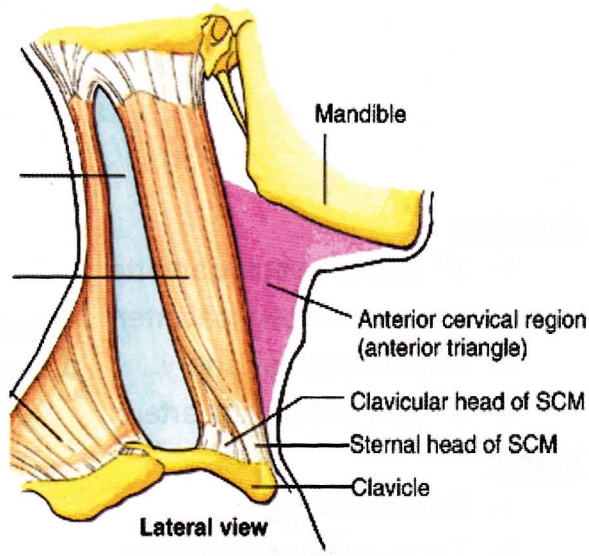




Anterior Triangle

Boundaries:

- Anteriorly: midline of the neck.
- Posteriorly: anterior border of sternomastoid.
- Base: lower border of mandible.

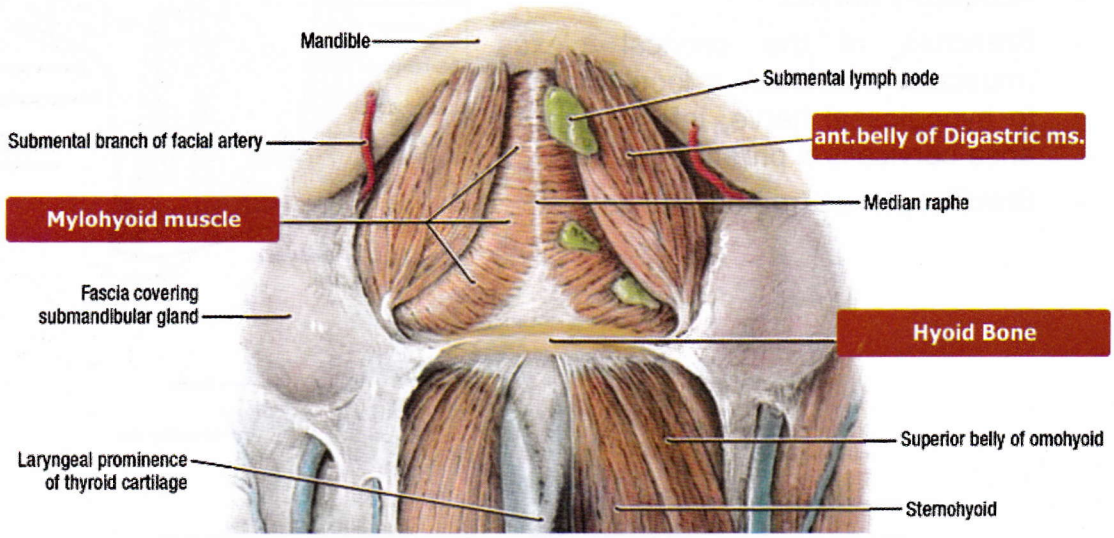


Subdivisions:

The digastric muscle & superior belly of omohyoid muscle divide the anterior triangle into 3½ Δ:

1- ½ Sub-mental Δ.
2- Digastric Δ.
3- Carotid Δ.
4- Muscular Δ.

Submental Triangle



Boundaries:

- ***Apex:*** symphysis menti.
- ***On either side:*** anterior bellies of digastric muscle.
- ***Base:*** body of hyoid bone.
- ***Floor:*** mylohyoid muscle.
- ***Roof:*** skin & fascia.

Contents: sub-mental LNs.

Digastric Triangle

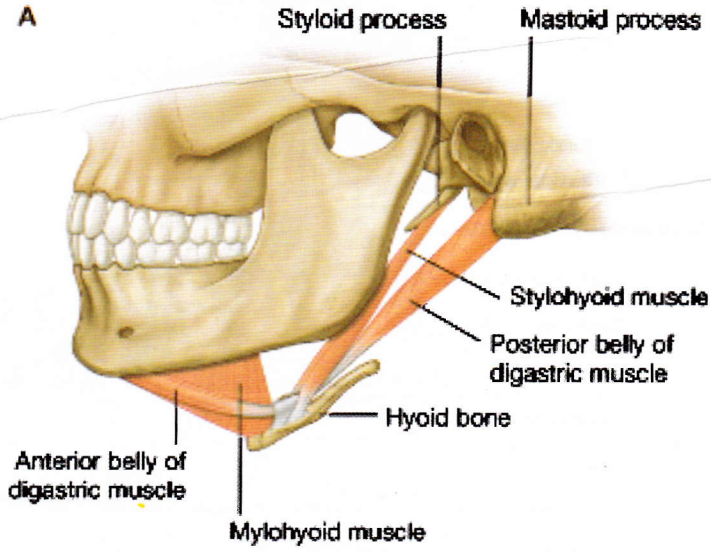
Boundaries:

1. **Above:** lower border of the mandible.
2. **Below**: two bellies of digastric muscle.

Floor: mylohyoid muscle in front and hyoglossus muscle behind.

Contents:

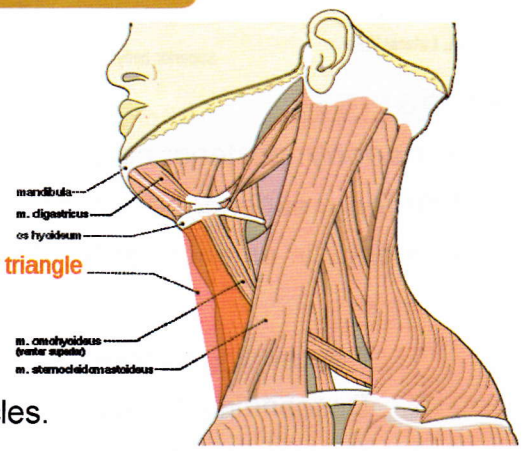
1. Submandibular salivary gland & LNs.
2. Facial artery & common facial vein.
3. Hypoglossal n. and submandibular ganglion.



Muscular Triangle

Boundaries:

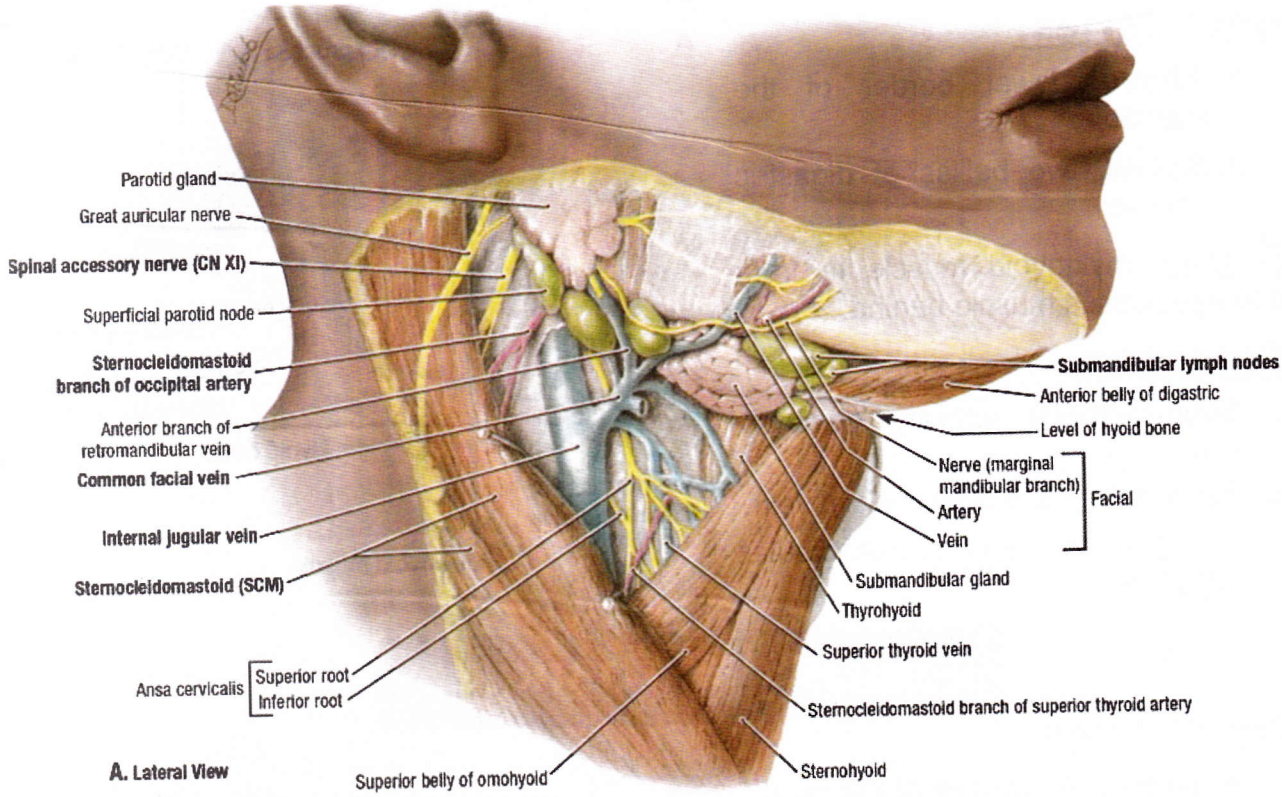
- ***Anteriorly***: midline of the neck.
- ***Postero-superiorly***: superior belly of omohyoid.
- ***Postero-inferiorly***: anterior border of sternomastoid.



Contents:

1. **Infra-hyoid muscles (strap muscles):**
   Sternohyoid, sternothyroid & thyrohyoid muscles.
2. **Lateral loop of thyroid gland**

Carotid Triangle



Boundaries:

MCQ

- ***Superiorly:*** posterior belly of digastric.
- ***Inferiorly:*** superior belly of omohyoid.
- ***Posteriorly:*** anterior border of sternomastoid.

Contents:

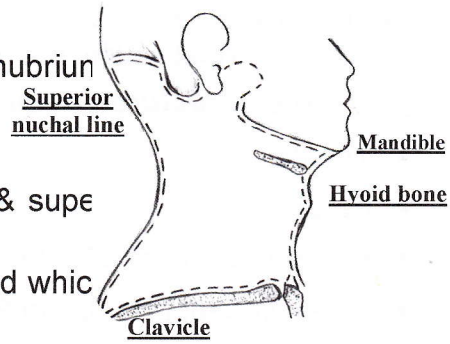
1. Descending hypoglossi.
2. Descending cervicalis.
3. Carotid sheath (CCA, ICA, vagus, IJV) + sympathetic chain.
4. Most of ECA branches.

DEEP FASCIA OF THE NECK

Investing Deep Fascia

It forms a layer in the anterior & posterior triangles of the neck

- The fascia splits to surround the **trapezius** & **sternomastoid.** MCQ
- **Inferiorly:** it splits to be attached to the manubriun clavicle.
- **Superiorly:**
  - It is attached to mandible, mastoid process & supe nuchal line.
  - Splits to form capsule around the parotid gland whic incomplete superiorly.

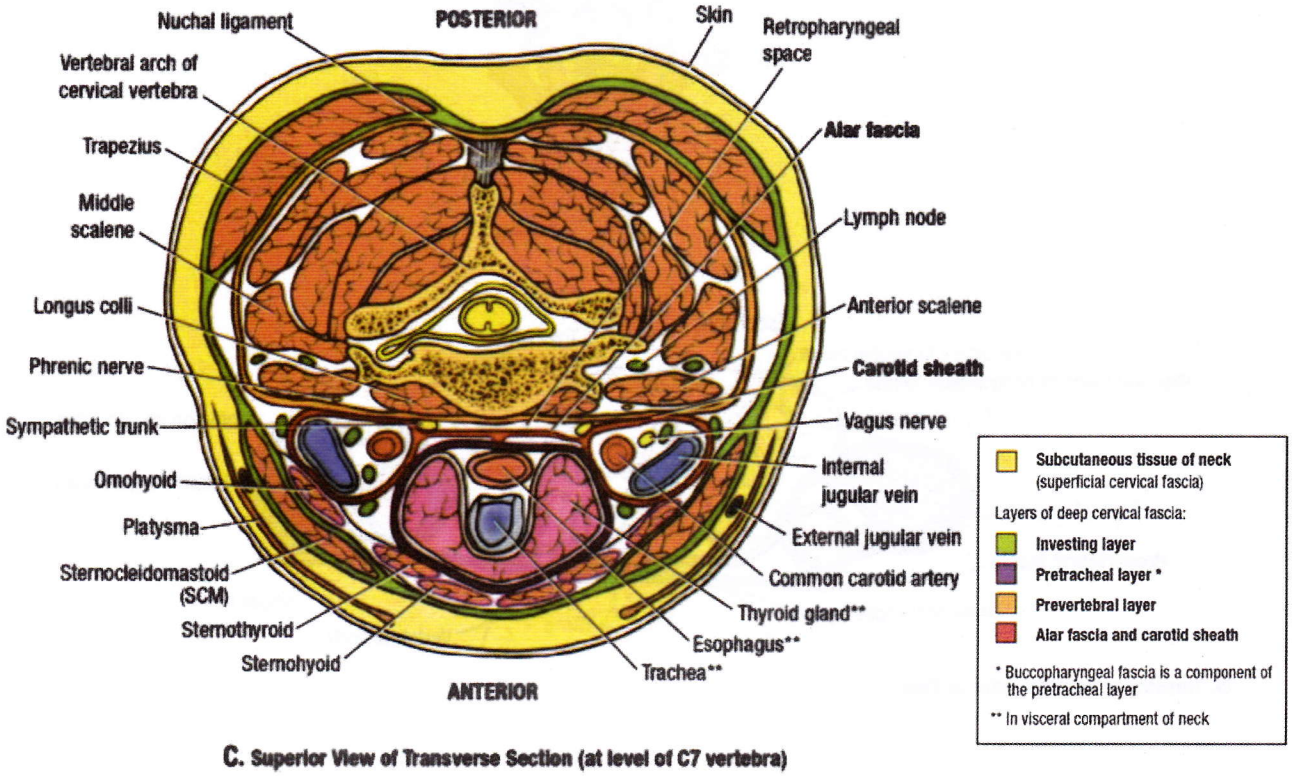


Surgical Importance:

MCQ
- Swellings of parotid gland elevate the ear.
- Parotid swellings are very painful due to tough parotid fascia.

MCQ

- **Stylo-mandibular ligament** is a thickened deep portion of parotid fascia.
- **Pterygo-mandibular raphe:** is a ligamentous band between pterygoid hamulus & posterior end of mylohyoid line).
- **Spheno-mandibular ligament** is a thickening in the pterygoid fascia.
- Axillary sheath is derived from pre-vertebral fascia.



C. Superior View of Transverse Section (at level of C7 vertebra)

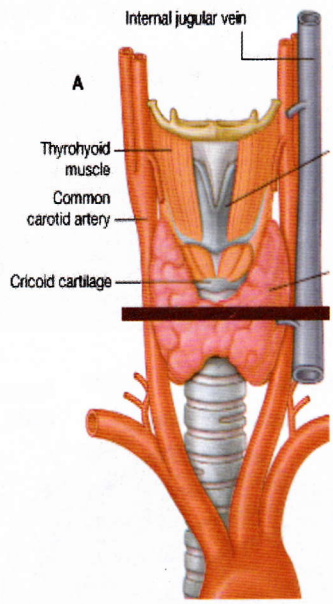
Pretracheal Fascia

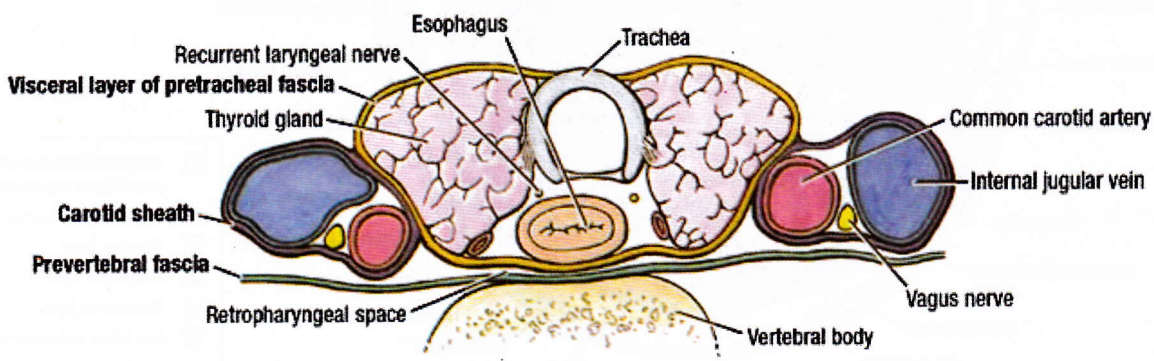
Attachment

- **Above:** to hyoid bone (so, thyroid gland moves up & down with deglutition).
- **Below:** to fibrous pericardium.
- **On each side:**
  - Fuses with carotid sheath.
  - It splits to form a capsule around thyroid gland. This capsule is thicker anterior (that is why the gland enlarges posterior at first).

Contents: *(i.e. structures mobile with deglutition)*

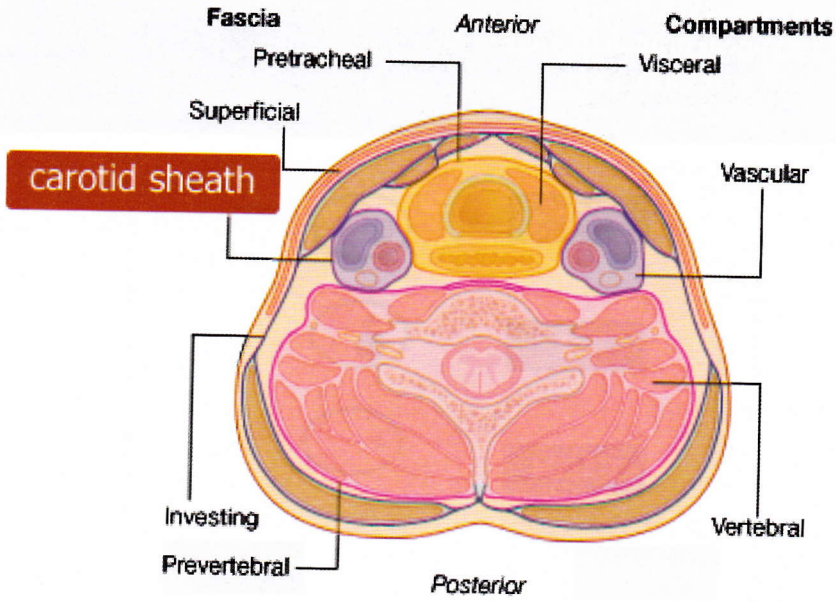
- Thyroid.
- Parathyroid.
- Pre-tracheal LNs (LN of Delphi).
- Pre-laryngeal LNs (LN of Poitier).
- Thyroglossal cyst & tract if found.





B. Transverse Section, Inferior View

Carotid Sheath



MCQ It is a tube of deep fascia extending from ***base of the skull*** down to ***root of the neck***

It surrounds the:

MCQ

1) ***Internal Jugular vein:*** laterally.
2) ***Common carotid & internal carotid artery:*** medially.

   N.B: *external carotid is not surrounded by the sheath.*
3) ***Vagus nerve:*** behind the interval between the internal jugular vein & common carotid artery.

Structures embedded in its walls:

1) ***Sympathetic trunk:*** embedded in posterior wall.
2) ***Ansa Cervicalis & its roots:*** embedded in the anterior wall.

Superficial Relations:

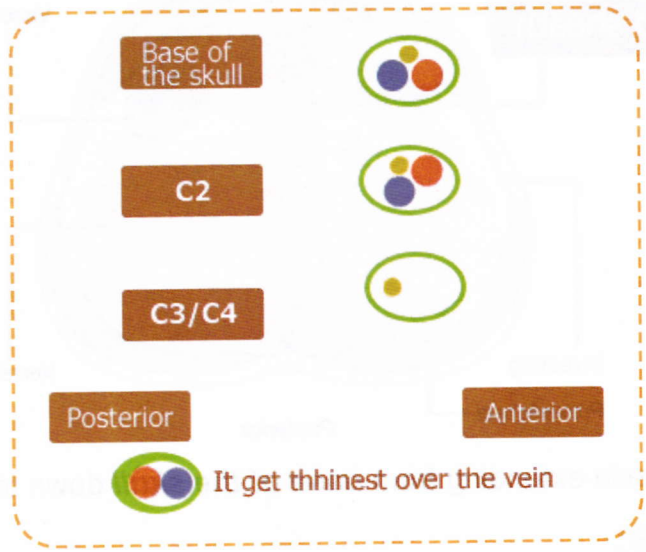
- ***Below the upper border of thyroid cartilage:***
  - Thyroid gland.
  - Infra-hyoid muscles (sternohyoid, sternothyroid, omohyoid).
  - Sternomastoid muscle.
- ***Above the upper border of thyroid cartilage:***
  - Styloid process and attached structures.
  - Posterior belly of digastric muscle.
  - Parotid gland.

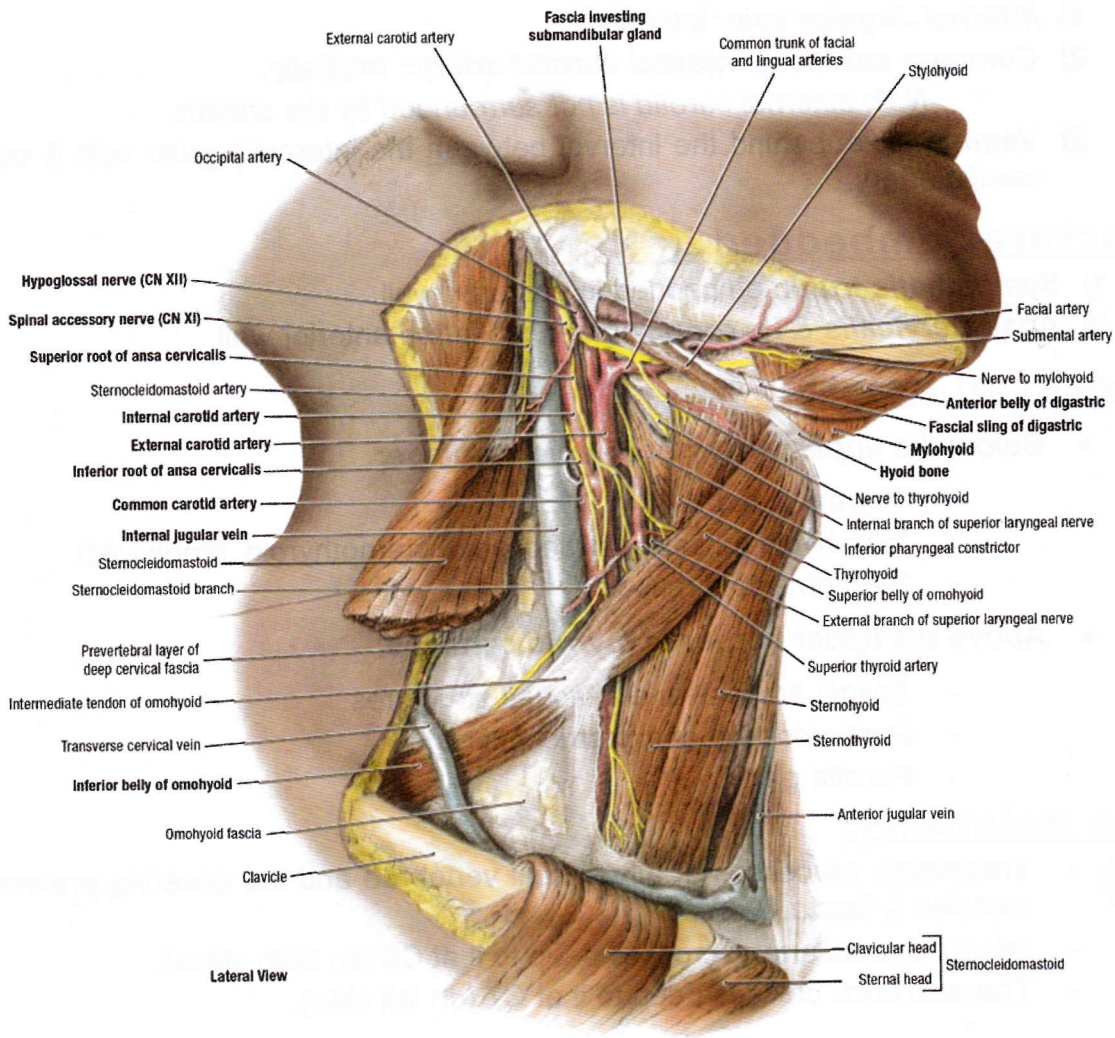
Deep Relations:

MCQ

- Transverse processes of all cervical vertebrae and the covering pre-vertebral muscles & fascia.
- Inferior thyroid artery: crosses deep to it at C6 (on both sides).
- Thoracic duct: crosses deep to it at C7 (on left side).

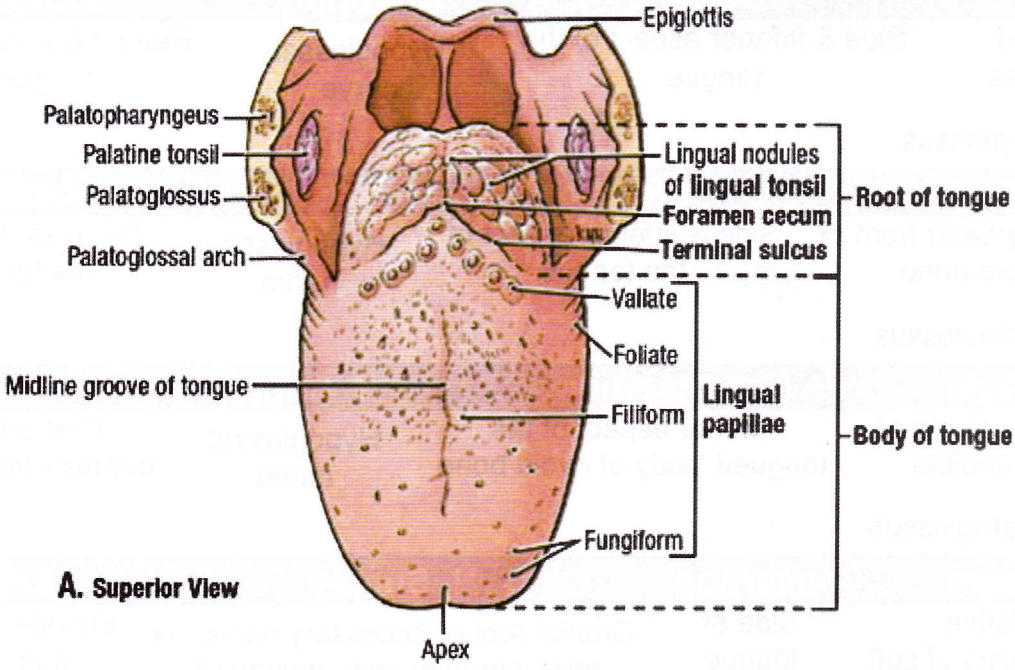
- **It fuses with pre-tracheal fascia and the investing fascia under the sternomastoid.**
- **The ansa cervicalis is in the carotid sheath over the internal jugular vein.**
- **Escaping from the upper sheath are:**
  - -Glossopharyngeal (IX)
  - -Superior laryngeal branch of vagus (X)
  - -Spinal root of accessory (XI)
  - -Hypoglossal (XII)





TONGUE

It is a muscular organ covered by mucus membrane, lying in the floor of mouth & oropharynx



Parts:

1- **Root:** through which muscles connect tongue to mandible & hyoid bone.

2- **Tip & margins:** lie opposite gum & teeth.

3- **Lower surface:** facing the floor of mouth & shows:

- ***Frenulum***; raised fold of mucosa in the midline.
- ***Deep lingual veins:*** on either sides of the frenulum.
- ***Fimbriated fold:*** raised mucosal fold.

4- **Dorsum of the tongue:** divided by *sulcus terminalis* into 2 parts:

- **Anterior ⅔:** contains papillae without lymphoid follicles.
- **Posterior ⅓:** contains lymphoid follicles without papillae.

MCQ

Sulcus terminalis of the tongue

- It is a V-shaped groove on the dorsum of the tongue with its apex directed posteriorly.
- It separates developmentally different parts of tongue.
- Circumvallate papillae lie just **in front** of it (however, it is innervated by IX)

Behind it lie lymphoid nodules under the mucous membrane.

Muscles of the Tongue:

A. Extrinsic muscles:

Styloglossus

Origin	Insertion	N. Supply	Action
Styloid process	Side & inferior aspect of the tongue	Hypoglossal nerve	Retract & elevate the tongue

Hyoglossus

Origin	Insertion	N. Supply	Action
Body & greater horn of hyoid bone	Side & inferior aspect of the tongue	Hypoglossal nerve	Depress & retract the tongue

Genioglossus

Origin	Insertion	N. Supply	Action
Genial tubercle of the mandible	Inferior aspect of the tongue& body of hyoid bone	Hypoglossal nerve	Protrudes & depress the tongue

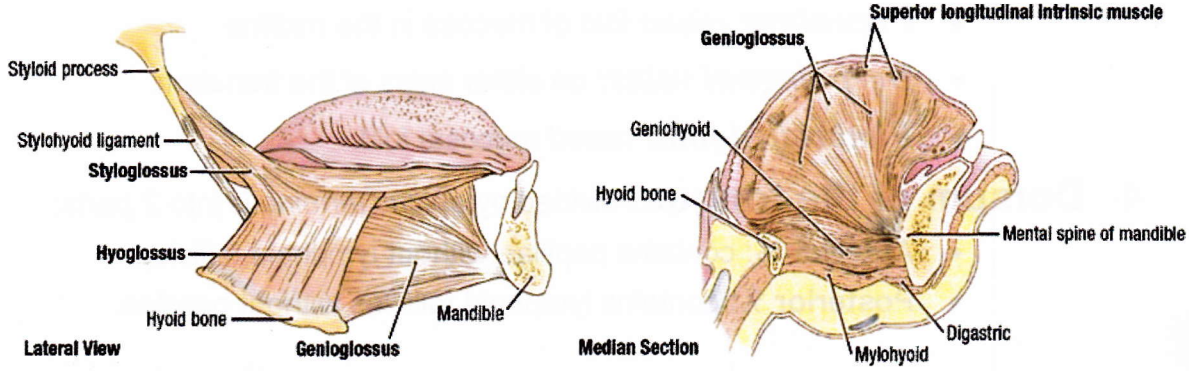
Palatoglossus

Origin	Insertion	N. Supply	Action
Palatine aponeurosis of soft palate	Side of tongue	Cranial root of accessory nerve via pharyngeal branch of vagus & pharyngeal plexus	Elevate posterior part of the tongue

B. *Intrinsic muscles*:

They have no bony attachments. They change the shape of the tongue:

- Superior & inferior longitudinal.
- Transverse & vertical muscles.



NB: *The superficial surface of hyoglossus muscle is related to*

- Lingual nerve.
- Submandibular duct.
- Submandibular ganglion.
- Hypoglossal nerve.

Nerve Supply:

MCQ

- Motor: all muscles supplied by hypoglossal n.

  Except palatoglossus supplied by spinal accessory n.

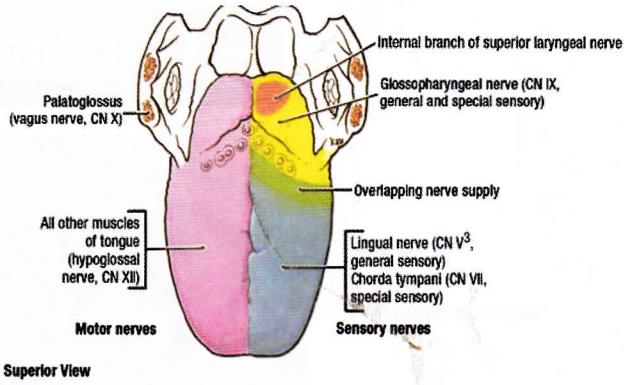
- Sensory:

➢ *Anterior ⅔:*

- V cranial nerve → general sensation.
- VII cranial n. → taste sensation.

➢ *Posterior ⅓ and circumvallate papillae:*

- IX cranial n. → general sensation & taste.



B. Superior View

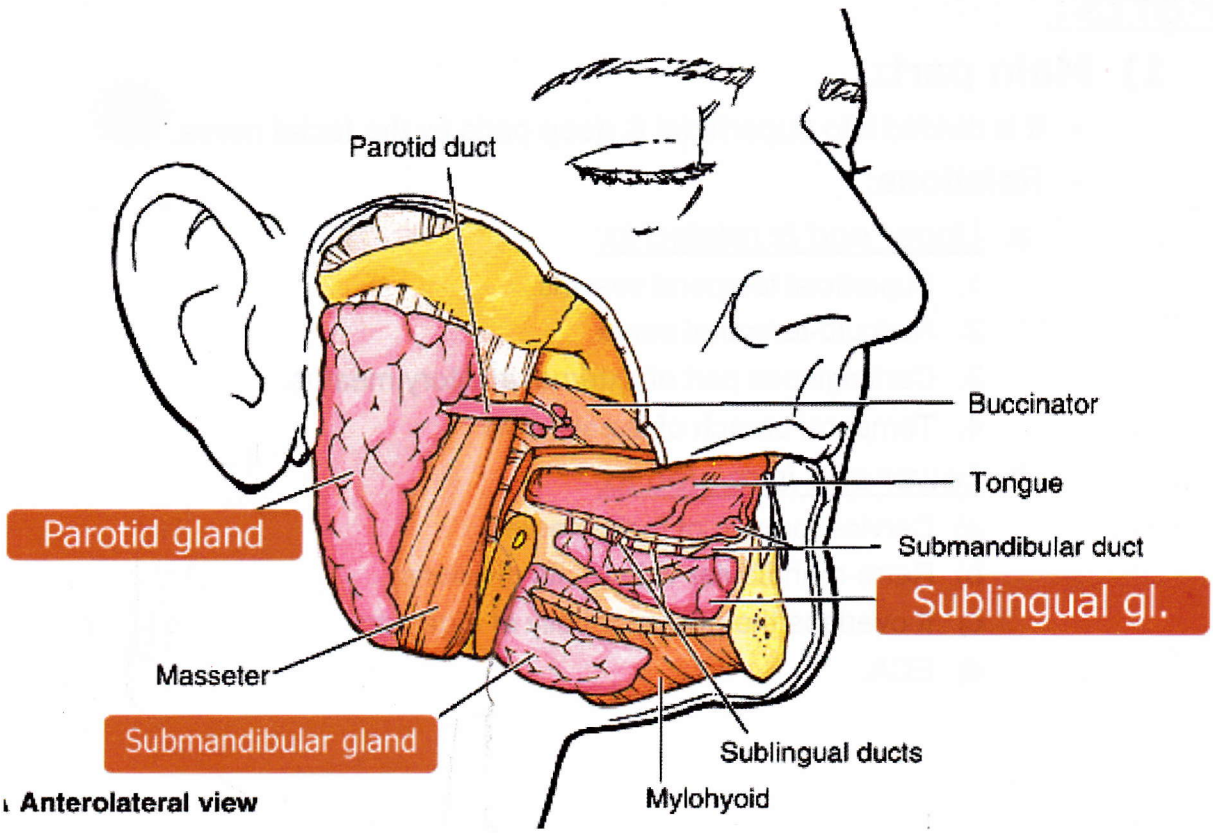
Blood Supply:

- **Lingual artery** (from external carotid).
- **Lingual vein** (to IJV).

Lymphatic drainage: (see lymphatic system)

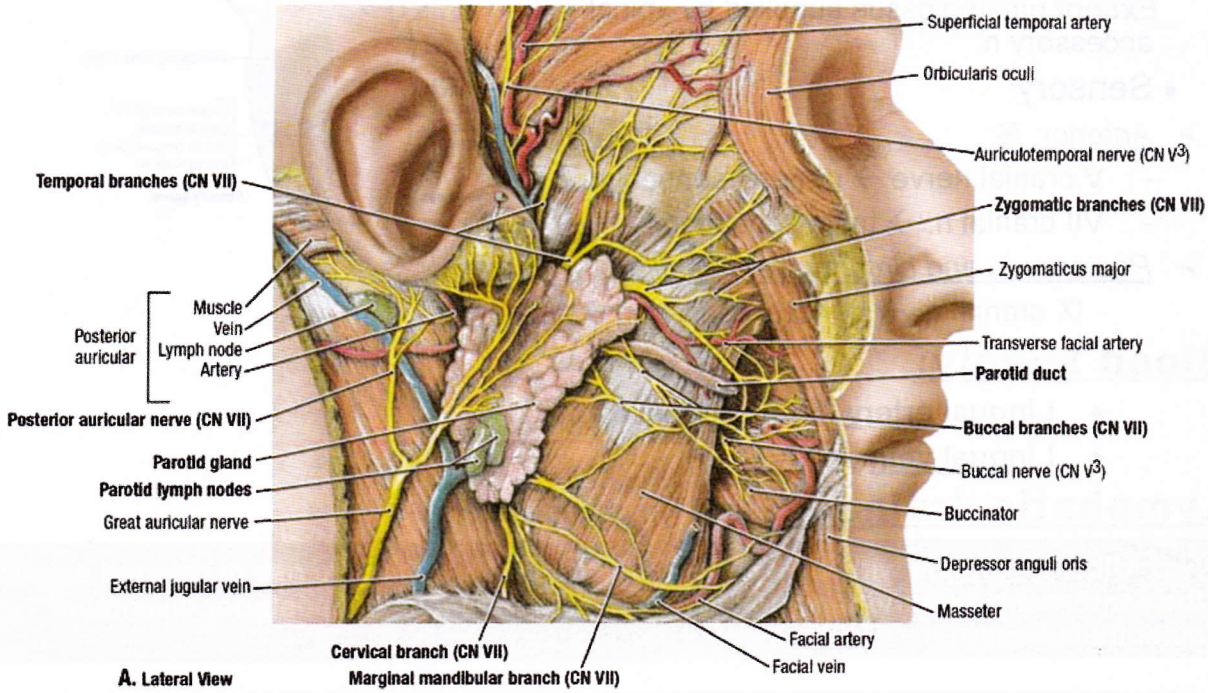
N.B: **Ulcer on tongue with involvement of lingual nerve can give rise to referred pain in the ear through auriculo-temporal nerve (both are branches of posterior division of mandibular nerve).** MCQ

Glands of Head & Neck



Anterolateral view

The Parotid Gland



A. Lateral View

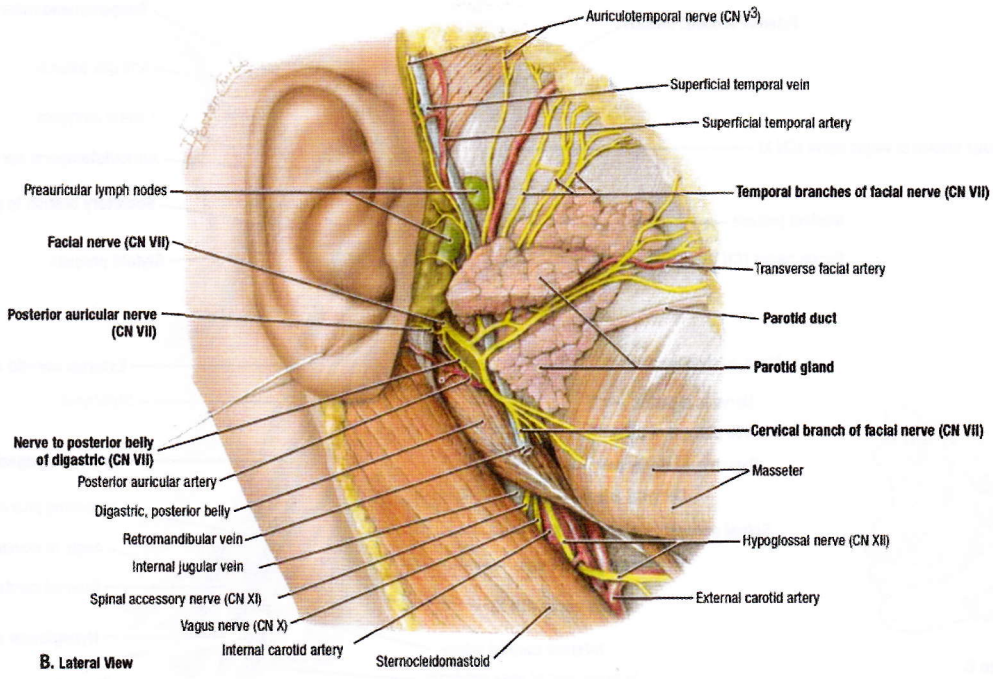
It is the largest salivary gland, which secretes serous fluids

Site: below the auricle, between the angle of mandible & sternomastoid muscle.

Parts:

1) Main part:

- It is divided into **superficial & deep** parts by the **facial nerve**. MCQ
- **Relations:**
  - *a. Upper end is related to:*
    1. Superficial temporal vessels.
    2. Auriculo-temporal nerve.
    3. Cartilaginous part of external auditory meatus.
    4. Temporal branch of facial nerve.
  - *b. Lower end is related to:*
    a) Cervical branch of facial nerve.
    b) Retro-mandibular vein (or its divisions).
    c) It overlaps the posterior belly of digastric.
    d) ECA.



c. Anterior border: *(from above downwards)*

a) Temporal branch of facial nerve.
b) Zygomatic branch of facial nerve.
c) Transverse facial artery (branch of superficial temporal).
d) Buccal branch of facial nerve.
e) Accessory parotid gland.
f) Parotid duct.
g) Mandibular branch of facial nerve.

d. Lateral surface : *(superficial relations)*

- Skin & fascia.
- Parotid LNs.
- Great auricular nerve.

e. Antero-medial surface:

MCQ

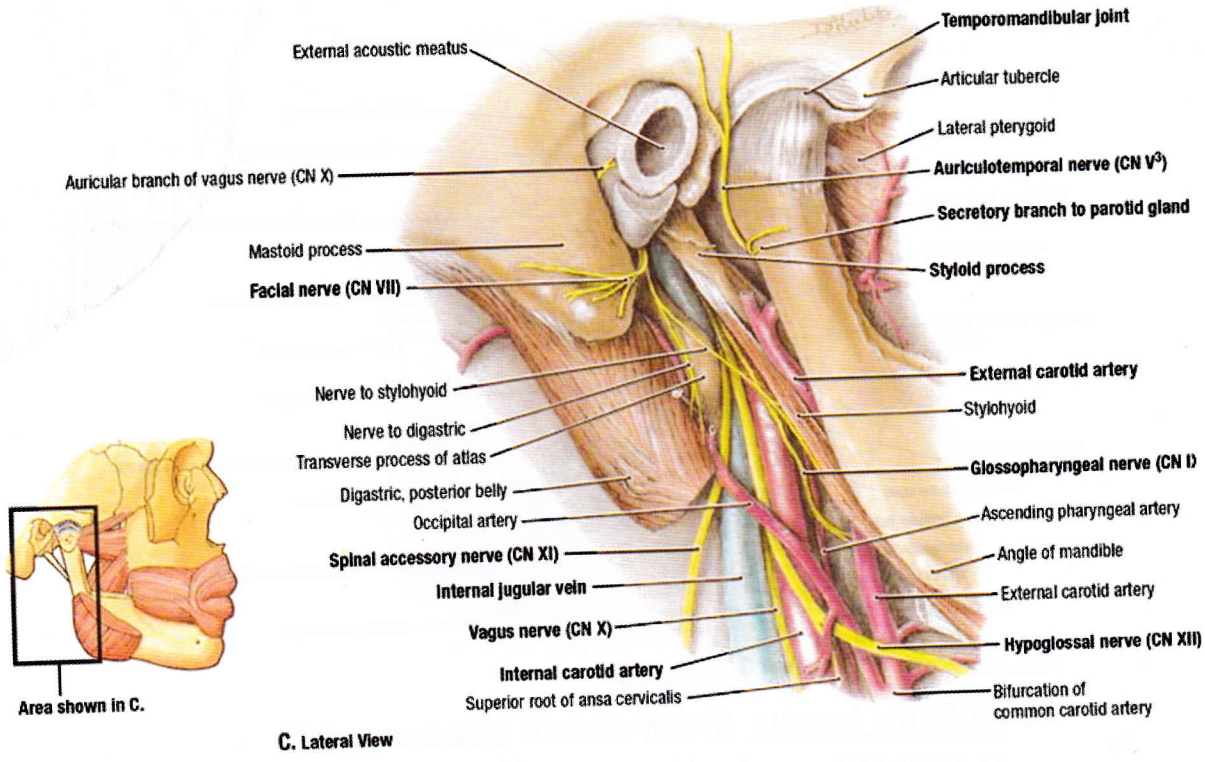
(Related to a bone in between two muscles)

- Ramus of the mandible.
- Masseter muscle (on the lateral surface of the ramus).
- Medial pterygoid m. (on medial surface of mandibular ramus).

f. Postero-medial surface: MCQ

(Related to a bone in between two muscles)

- Mastoid process.
- Sternomastoid muscle (on the lateral surface of mastoid process).
- Posterior belly of digastric (on the medial surface of the mastoid process).
- It is also related to the styloid process and the muscles and ligaments attached to it.
- The styloid process intervenes between the parotid gland both the internal carotid artery and internal jugular vein in carotid sheath



C. Lateral View

2) Accessory Part:

Semi-detached part of the gland, which lies just above the parotid duct.

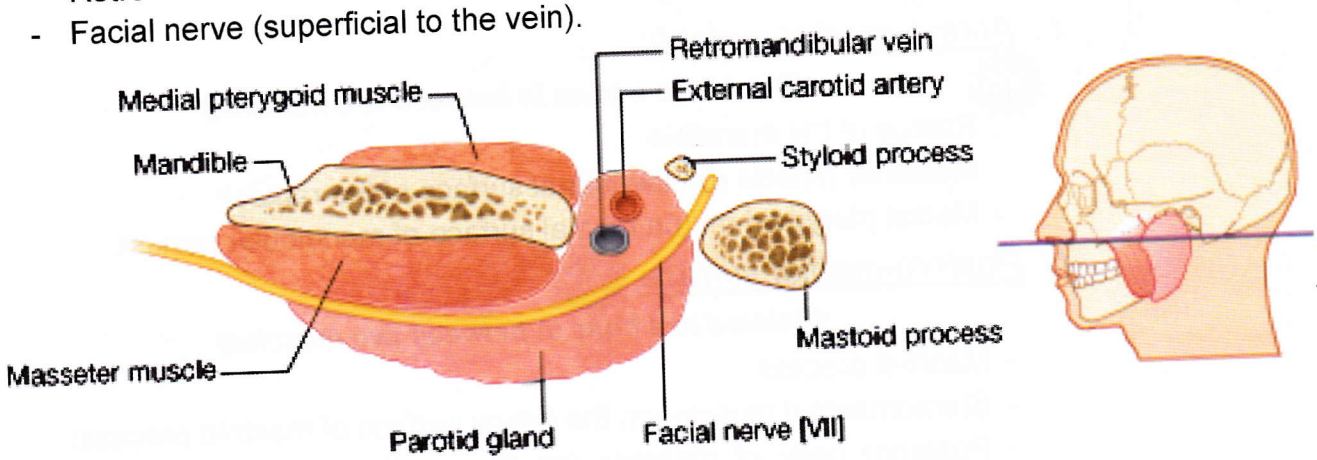
3) Parotid (Stensen's) duct:

- 5 cm long.
- Emerges from the anterior border.
- Runs superficial to masseter m. then pierces the buccinator.
- Opens in the vestibule of mouth, opposite the upper 2nd molar tooth.

MCQ

Structures within the gland: MCQ

- External carotid artery (deepest).
- Retro-mandibular vein (superficial to the artery).
- Facial nerve (superficial to the vein).



Capsule:

1) The gland is enclosed within a sheath of deep fascia of the neck called *parotid fascia*. The deep layer of this fascia which extends from the styloid process to the angle of the mandible is thickened to form the *stylo-mandibular ligament*.

MCQ 2) Fibrous capsule.

Blood Supply:

Arterial supply: external carotid artery inside the gland.

Venous drainage: retro-mandibular vein.

Lymphatic Drainage

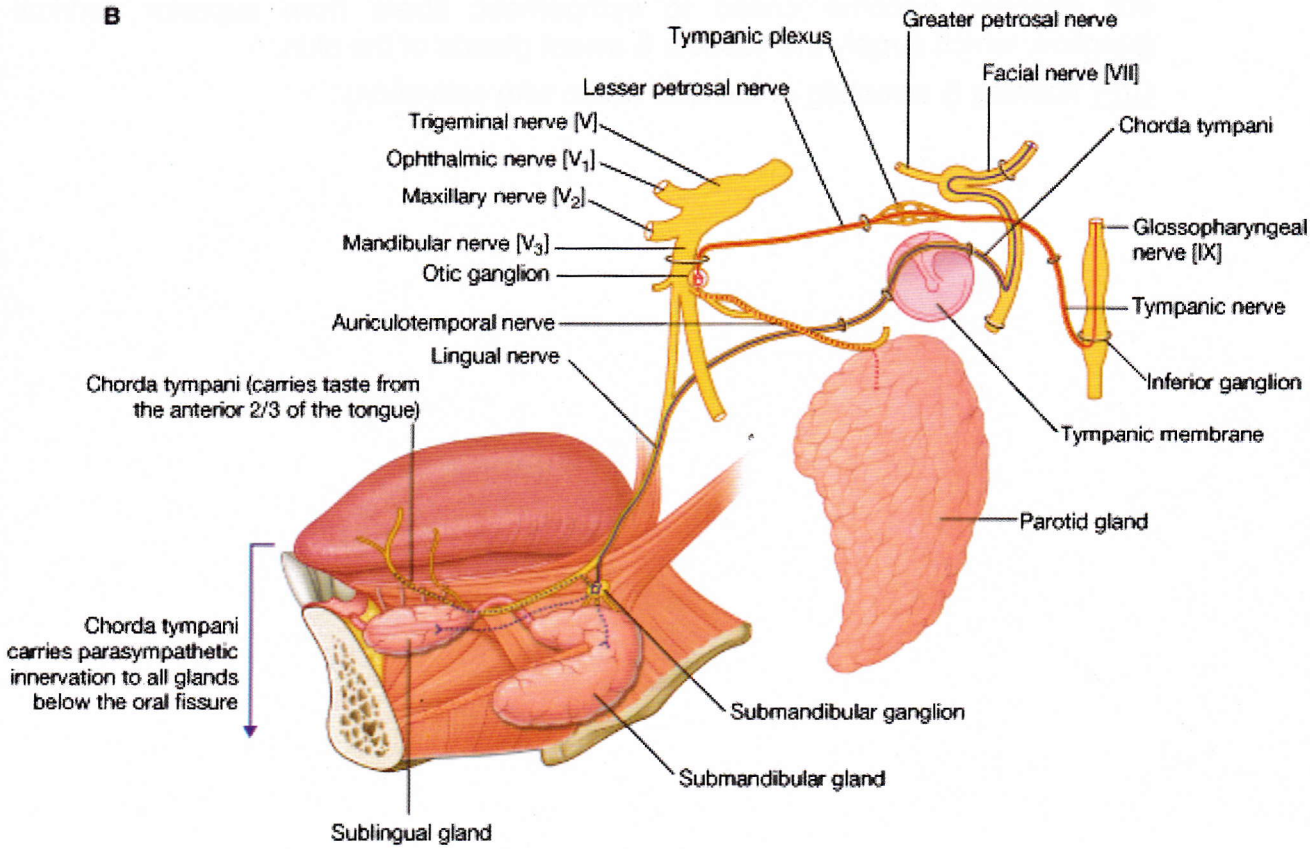
Superficial & deep parotid LN → upper deep cervical LN.

Nerve supply of the Gland:

1. ***Sensory:*** from the auriculo-temporal nerve (the capsule), while great auricular n. supplies the skin overlying the gland.
2. ***Sympathetic:*** from the sympathetic plexus around the external carotid.
3. ***Parasympathetic:***

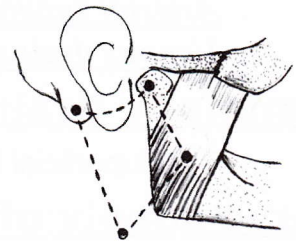
MCQ

- ***Secretomotor*** fibers arise from inferior salivary nucleus in medulla oblongata and join the ***glossopharyngeal nerve*** **(9th cranial)**.
- These fibers leave the 9th nerve through its **tympanic branch** which enters the middle ear where it joins the **tympanic plexus**.
- The **lesser petrosal** nerve arises from the tympanic plexus as a continuation of the tympanic branch. It leaves the middle ear through the *lesser petrosal foramen* and enters the *foramen ovale* to relay in the ***otic ganglion*** (i.e. it is pre-ganglionic).
- Postganglionic fibers arise from the otic ganglion and join ***auriculo-temporal nerve*** through which they reach the gland.



Surface Anatomy:

A- Parotid Gland: connect the following 4 points:



- Head of the mandible.
- Middle of masseter muscle.
- 2 cm below & behind the angle of mandible.
- Center of mastoid process.

B-Parotid Duct:

It corresponds to the middle ⅓ of a horizontal line drawn from the tragus of the ear to a point on the upper lip midway between the ala of the nose and the angle of the mouth.

Points of Surgical Importance:

1-Parotid abscess should be drained by ***Hilton technique*** (to avoid injury of the facial nerve). MCQ

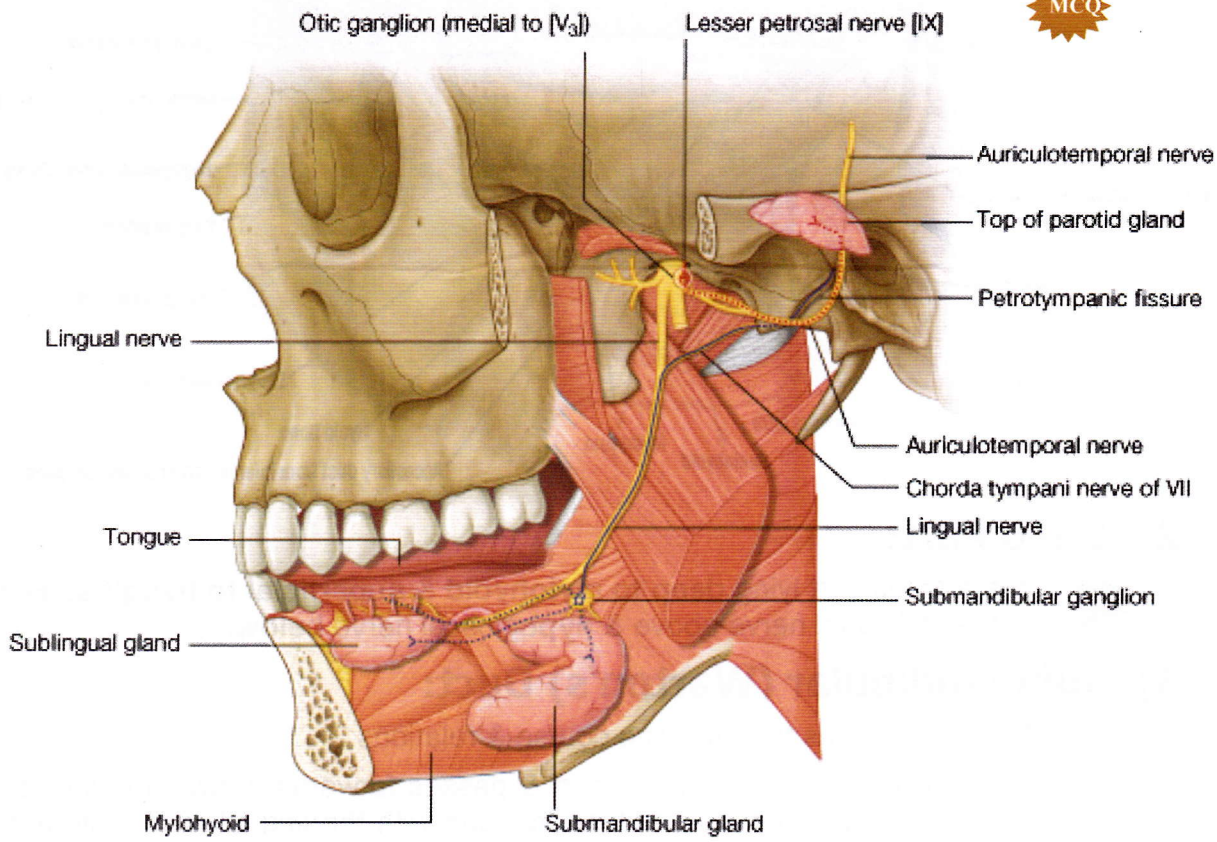
2-Frey's syndrome (gustatory syndrome):

- It follows surgery in the parotid region or tempromandibular joint.
- After injury of auriculotemporal N. post-ganglionic parasympathetic fibers from otic ganglion become united to sympathetic fibers from superior cervical ganglion, which supply the vessels & sweat glands of the skin.
- **C/P:** flushing & sweating of the skin (even with salivation).

Submandibular Gland

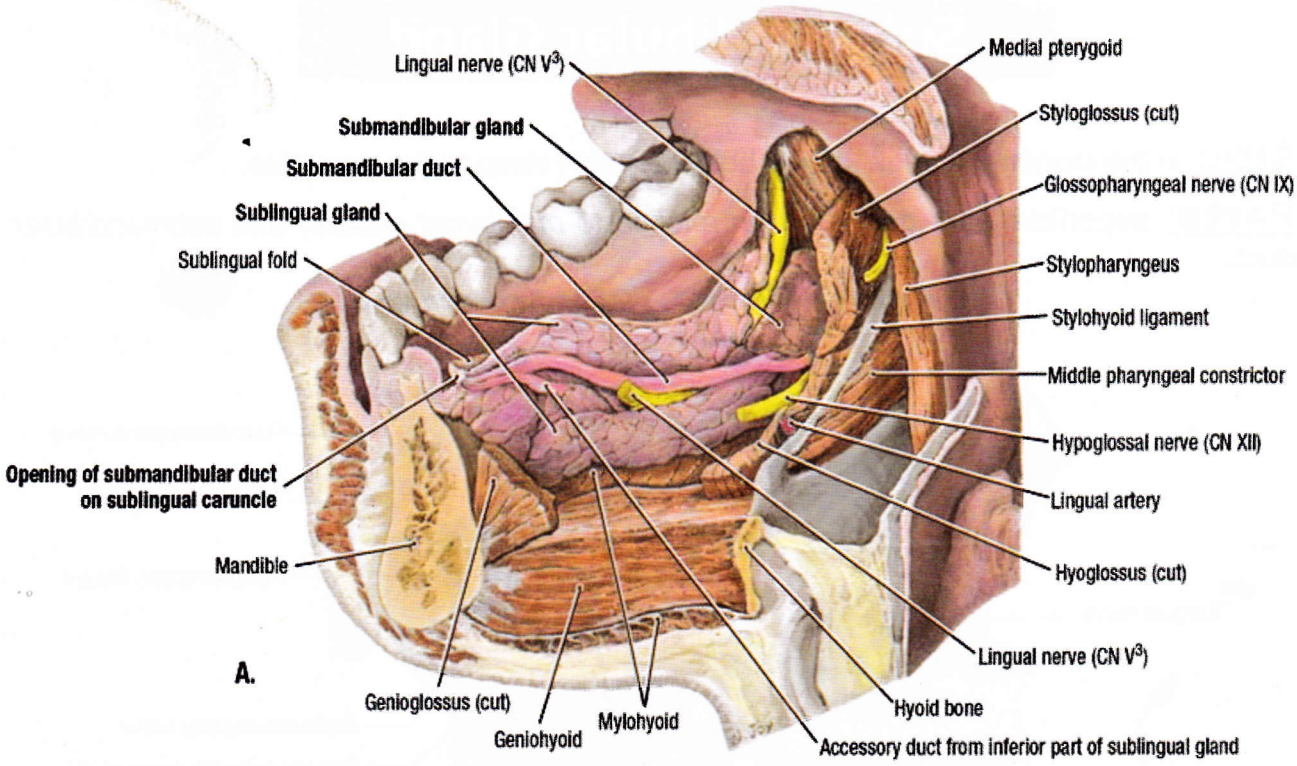
Site: in the digastric triangle, partly below & partly deep to the mandible.

Parts: superficial part, deep part *(in relation to mylohyoid muscle)* and submandibular duct.



1) Superficial Part:

- *Wedge shaped, extending:*
  - Posteriorly: to the angle of mandible.
  - Superiorly: to mylohyoid line of mandible.
  - Inferiorly: it overlaps the 2 bellies of digastric muscle.
- ***Relations:***
  - **Infero-lateral surface:** related to skin, superficial fascia (containing platysma, cervical branch of facial nerve, anterior facial vein and LNs) & deep fascia.
  - **Lateral surface:** related to the submandibular fossa of the mandible, facial artery, mylohyoid nerve & vessels.
  - **Medial surface:** related to 2 muscles (mylohyoid & hyoglossus) & 2 nerves (lingual & hypoglossal).



2) Deep Part:

MCQ It is a small part lying **deep to mylohyoid** & **superficial to hyoglossus** & between lingual nerve above & **hypo**glossal nerve **below.**

3) Submandibular (Warton's) Duct:

5 cm long. It has the following course & relations:

- It arises from the deep part & passes forwards between mylohyoid & hyoglossus, having triple relation with the lingual n. (1st lateral to the n., then below it & finally medial to it).
- MCQ It ends by opening into the floor of the mouth **(on top of sublingual papilla)** close to frenulum of the tongue.

Nerve Supply:

1- Sensory: lingual nerve.

2- Sympathetic: plexus around the facial artery.

3- Parasympathetic:

MCQ
- It receives secretomor fibers from the **submandibular ganglion**.
- Passes through **chorda tympani** from facial nerve.

Lymphatic Drainage: to submandibular & upper deep cervical LNs.

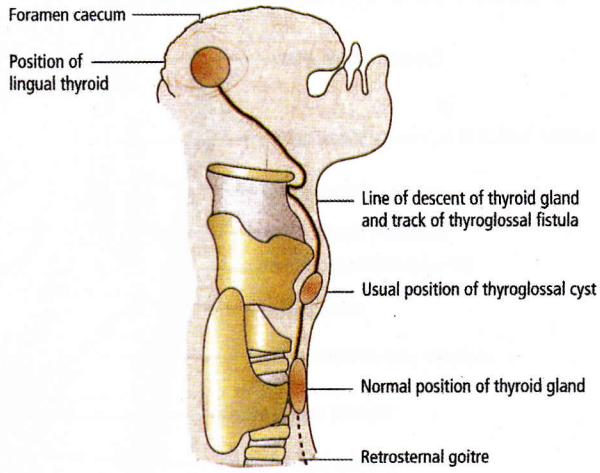
Points of surgical importance:

Facial artery should be double ligated during operation for submandibular salivary gland

Thyroid Gland

Embryology

- From the floor of the pharynx at the foramen caecum which descends in the neck to form both lobes & isthmus.
- From the 4th branchial arch which gives the superior parathyroid and para-follicular C cells (neural crest).



Anatomy

- The thyroid is one of the largest endocrine glands **weighing** approximately 20 gm & **measuring** 4 x 2.5 x 2 cm.
- It is situated in the neck **opposite** to the **5th, 6th**, & **7th** cervical vertebrae.
- Normal thyroid is made up of 2 lobes joined by thin band of tissues; the isthmus.
- The apex of the lobe lies on the thyroid cartilage below the oblique line while its base is at the level of **the 6th tracheal ring**.
- Its isthmus lies opposite **the 2nd, 3rd & 4th tracheal rings**. MCQ

Capsule of the thyroid gland:

MCQ

1. ***True capsule*** from the stroma of the gland.
2. ***False capsule*** from the pre-tracheal fascia.

Relations:

A) Superficial Relations:

- Skin, SC tissue, platysma muscle.
- Investing layer of deep cervical fascia. MCQ
- Sternomastoid muscle (nerve supply: spinal part of XI cranial nerve).
- Strap muscles (sternothyroid, sternohyoid & omohyoid muscles) → supplied by ansa cervicalis from below → cut the muscles as high as possible.
- Pre-tracheal fascia.

B) Medial Relations:

- ***Lower part***

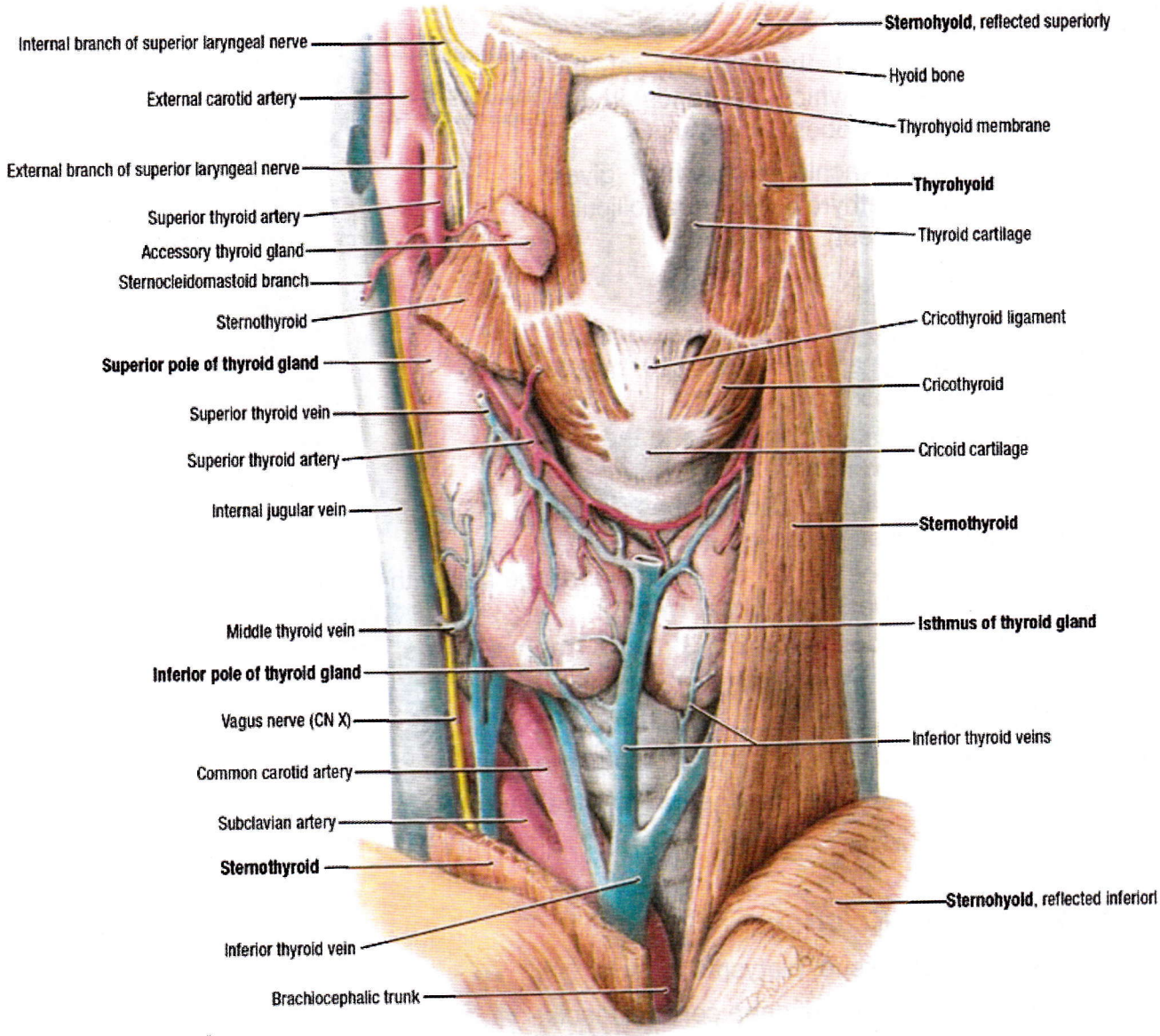
  Trachea, esophagus with recurrent laryngeal nerve in between.

- ***Upper part***

MCQ Cricoid and thyroid cartilages, cricothyroid muscle and inferior constrictor of the pharynx. (i.e. pharynx & larynx).

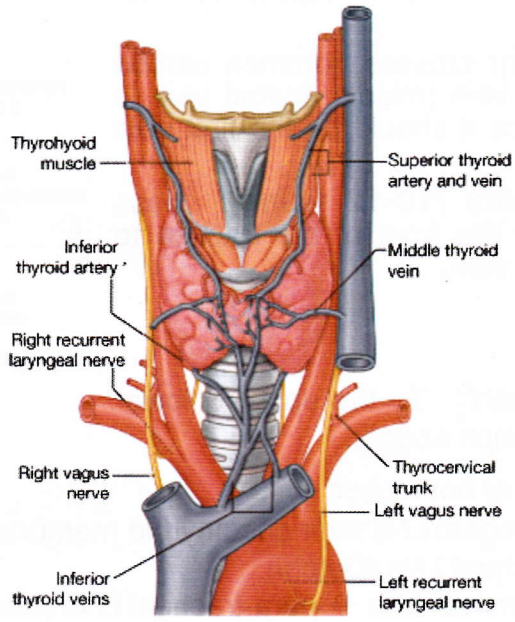
C) Posterior relations

Carotid sheath (the carotid artery, the internal jugular vein & the vagus) & sympathetic chain.



A. Anterior View

Blood supply: MCQ



Arterial Supply

1) Superior Thyroid artery:

- The 1st branch of the external carotid artery.
- It is related to the external laryngeal nerve (when injured, it leads to loss of high pitched voice & voice fatigue).

2) Inferior Thyroid artery (inverted L-shaped course):

From the thyro-cervical trunk which is a branch of 1st part of subclavian artery. Its terminal branches near the gland are in close relation to recurrent laryngeal nerve (in between, above or below terminal branches).

3) Thyroida ima artery:

From the arch of aorta or innominate artery (present in 1 - 3% of people → severe bleeding during thyroidectomy).

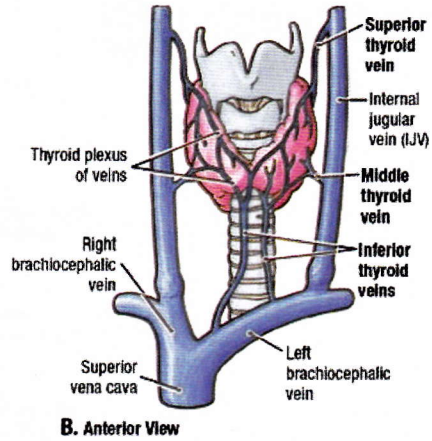
4) Accessory Tracheal & Esophageal arteries:

In ligament of Berry's; which is a thickened part of the pre-tracheal fascia that joins trachea to the thyroid gland.

- Slipping of the ligature of the Inferior thyroid artery → stump falls in the chest → bleeding in chest → treated by thoracotomy, so, ligate in continuity.
- Lower part of the gland is preserved in surgery & will be supplied by accessory esophageal & tracheal branches.
- **Branches of thyro-cervical trunk:**
  1. Inferior thyroid artery
  2. Transverse cervical artery.
  3. Supra-scapular artery

Venous Drainage

1. ***Superior Thyroid v:*** to internal jugular vein (or common facial vein).
2. ***Middle Thyroid vein:*** crosses common carotid to join internal jugular vein (middle thyroid vein is the shortest vein; hence it should be the first vein to be tied & cut).
3. ***Inferior Thyroid veins (10-12 veins):*** pass from the isthmus over the front of the trachea to join the left innominate vein.



B. Anterior View

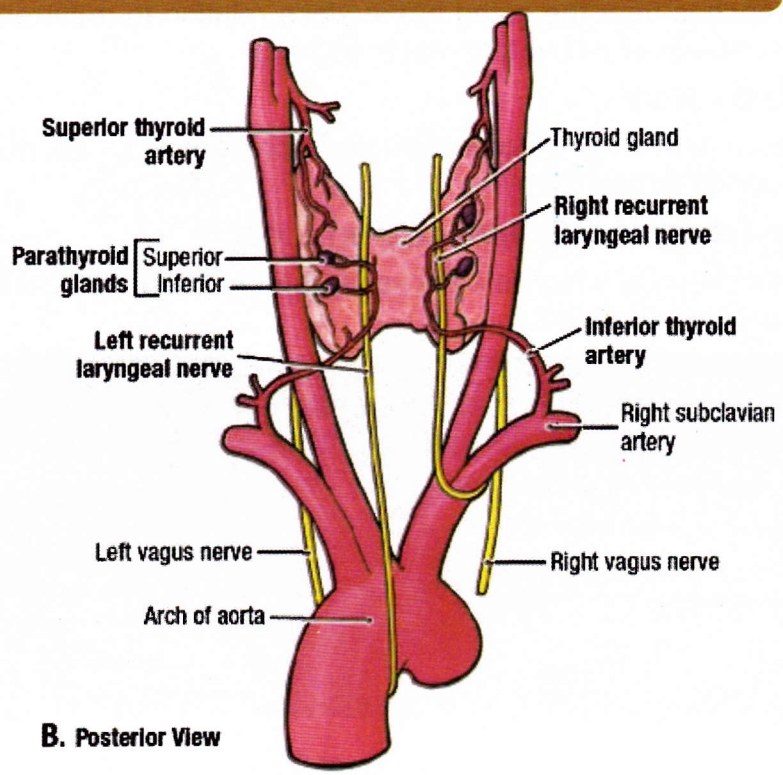
Lymph Drainage:

- ***Peripheral part:*** To the upper & lower deep cervical lymph nodes.
- ***Medial parts*** of both lobes →
  1) Pre-laryngeal LNs over cricothyroid membrane (gland of Poirier).
  2) Pre-tracheal LNs (Delphi).
  3) Deep cervical LNs → para-tracheal LNs (mediastinal).

Structure of the Thyroid Gland

- It is formed of follicles lined with cuboidal epithelium (which is the parenchyma) & vascular CT stroma.
- No basement membrane.

Recurrent Laryngeal Nerve



B. Posterior View

Origin: The nerve arises from the vagus.

Course:

- The nerve on the Rt. side turns around the 1st part of Rt. subclavian artery & on the left side turns around the arch of the aorta.
- The nerve runs in groove between the trachea & esophagus in close to the terminal branches of the inferior thyroid artery.
- It enters the larynx at the inferior horn of thyroid cartilage.

It supplies: All intrinsic ms of the larynx except cricothyroid muscle (external laryngeal) & the mucous membrane below the vocal cords.

Surgical importance:

- The nerve might be non recurrent in small percent of cases (2%) & in this situation it might be injured with ligation of the middle thyroid vein.
- Ligation of inferior thyroid artery should be performed away from the gland to avoid injury to the nerve.

Injury to the Recurrent Laryngeal Nerve leads to			
Complete		Partial	
Unilateral	Bilateral	Unilateral	Bilateral
↓	↓	↓	↓
Hoarseness of voice	Aphonia	Dysnea on exertion	Stridor
الصوت		النفس	

*NB: Fibers of the **add**uctors are in the mi**dd**le of the recurrent laryngeal n. while the fibers of abductors are in the periphery.*

External Laryngeal Nerve

Origin: It arises from the superior laryngeal n. of the vagus.

Course: It passes in close relation to superior thyroid artery.

It supplies:

MCQ
- *Cricothyroid muscle (responsible for high pitched voice - tenses vocal folds)*
- *Inferior constrictor muscle*

Injury: causes loss of high pitched voice..

Surgical Importance:

Superior thyroid artery should be ligated as near as possible to the gland to avoid injury of the nerve.

MCQ The superior laryngeal nerve gives also the internal laryngeal nerve, which supplies the mucous membrane of the larynx till vocal cords, if injured → choking.

Parathyroid Gland

Embryology:

- 3rd pharyngeal pouch → inferior parathyroid.
- 4th pharyngeal pouch → superior parathyroid.

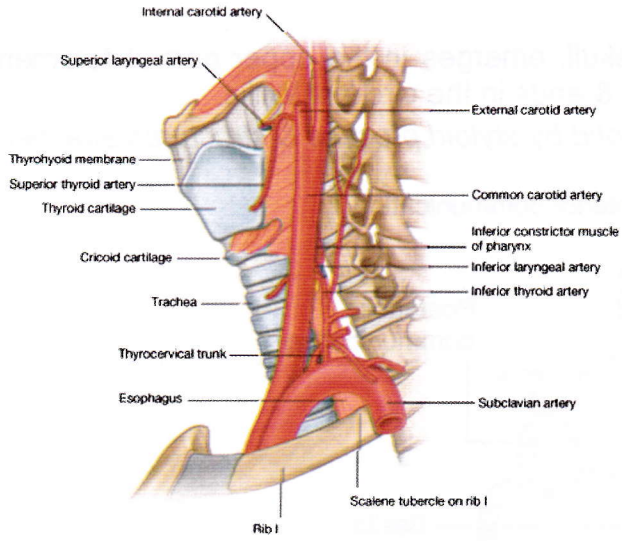
Anatomy: They are 4 in number

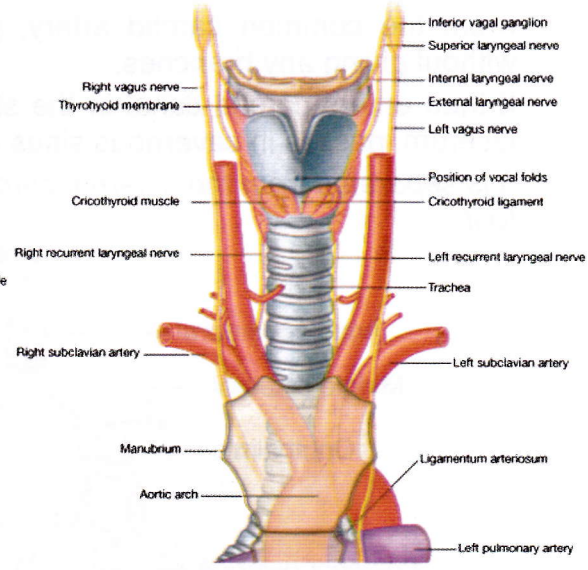
- ***Size:*** each gland is about 0.5 cm.
- ***Color:*** yellowish brown.
- ***Position:***
  - They are usually embedded in the back of the false capsule (rarely in the substance of the gland).
  - Superior parathyroid is more constant in position (posterior to thyroid & above inferior thyroid artery).
  - Inferior parathyroid may rarely be located in superior mediastinum.

Pituitary gland

The **pituitary gland**, or **hypophysis**, is an endocrine gland about the size of a pea and weighing 0.5 g. It is a protrusion of the bottom of the hypothalamus at the base of the brain, and rests in a small, bony cavity **(sella turcica)** covered by a dural fold **(diaphragma sellae)**. The pituitary fossa, in which the pituitary gland sits, is situated in the sphenoid bone in the middle cranial fossa at the base of the brain.

Common Carotid Artery





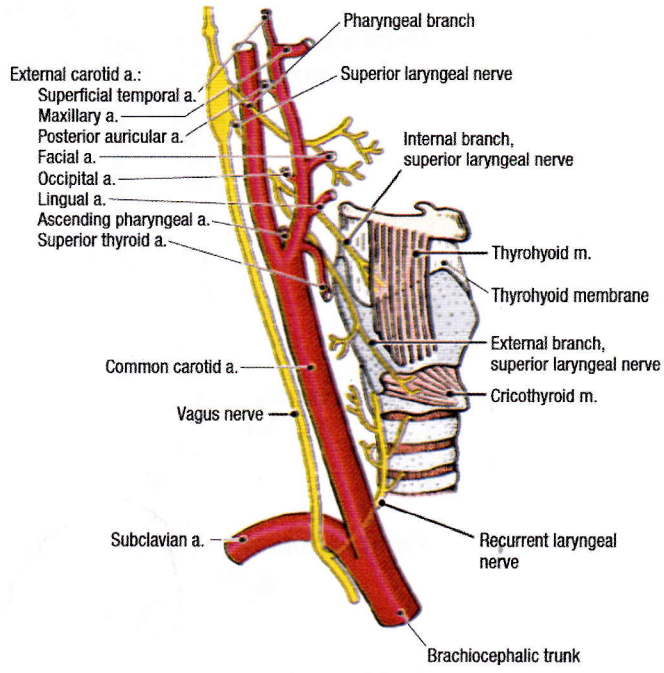
Begins

- The Rt. is a branch of the innominate artery.
- The Lt. is a branch of the aortic arch.

Course & relations:

MCQ

- Each common carotid artery enters the neck behind the sterno-clavicular joint.
- It ascends inside the carotid sheath, medial to the internal jugular vein & between them is the vagus nerve.
- is crossed antero-laterally by omohyoid & sternomastoid muscle.



Ends: at the level of the upper border of thyroid cartilage (between C_3 & C_4) by dividing into external & internal carotid arteries.

- At its bifurcation, the common carotid has baro- & chemo-receptors which are richly innervated by the glossopharyngeal nerve.
- Carotid pulsation is felt by compression against *carotid tubercle of transverse process of C6.*

Exposure

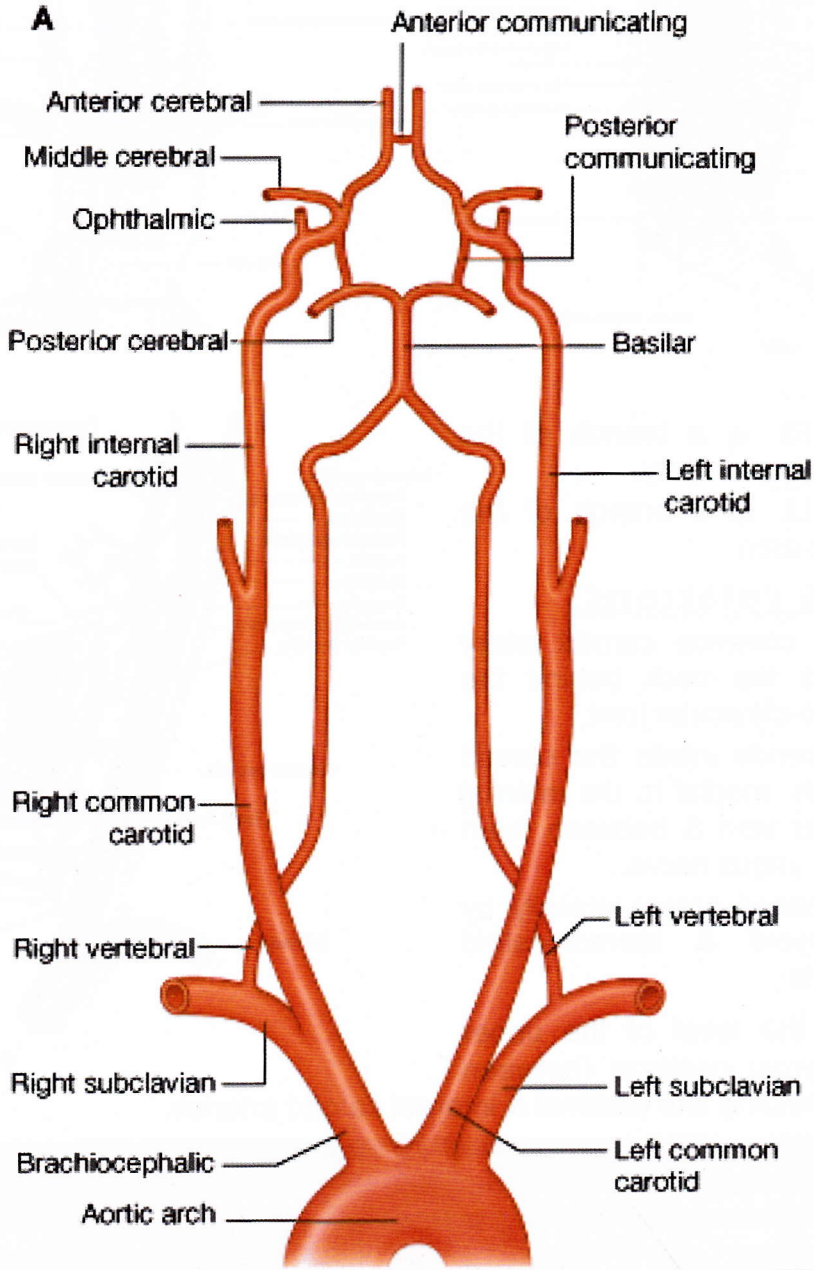
- Median sternotomy incision is continued along the anterior border of sterno-mastoid to the tip of the mastoid process or it is commenced in the neck.
- The incision is carried down through SC tissue & platysma. After division of external jugular vein, the cervical fascia is opened along the anterior border of sternomastoid which is retracted laterally to expose the carotid artery.

Internal Carotid Artery

MCQ

Course

- From the common carotid artery, passes in the neck inside carotid sheath without giving any branches.
- It then enters carotid canal in the skull, emerges in the upper part of foramen lacerum, passes in cavernous sinus & ends in the circle of Willis.
- *It is separated from the external carotid by styloid process & structures attached to it.*



Branches: *It is the principal artery of the brain*

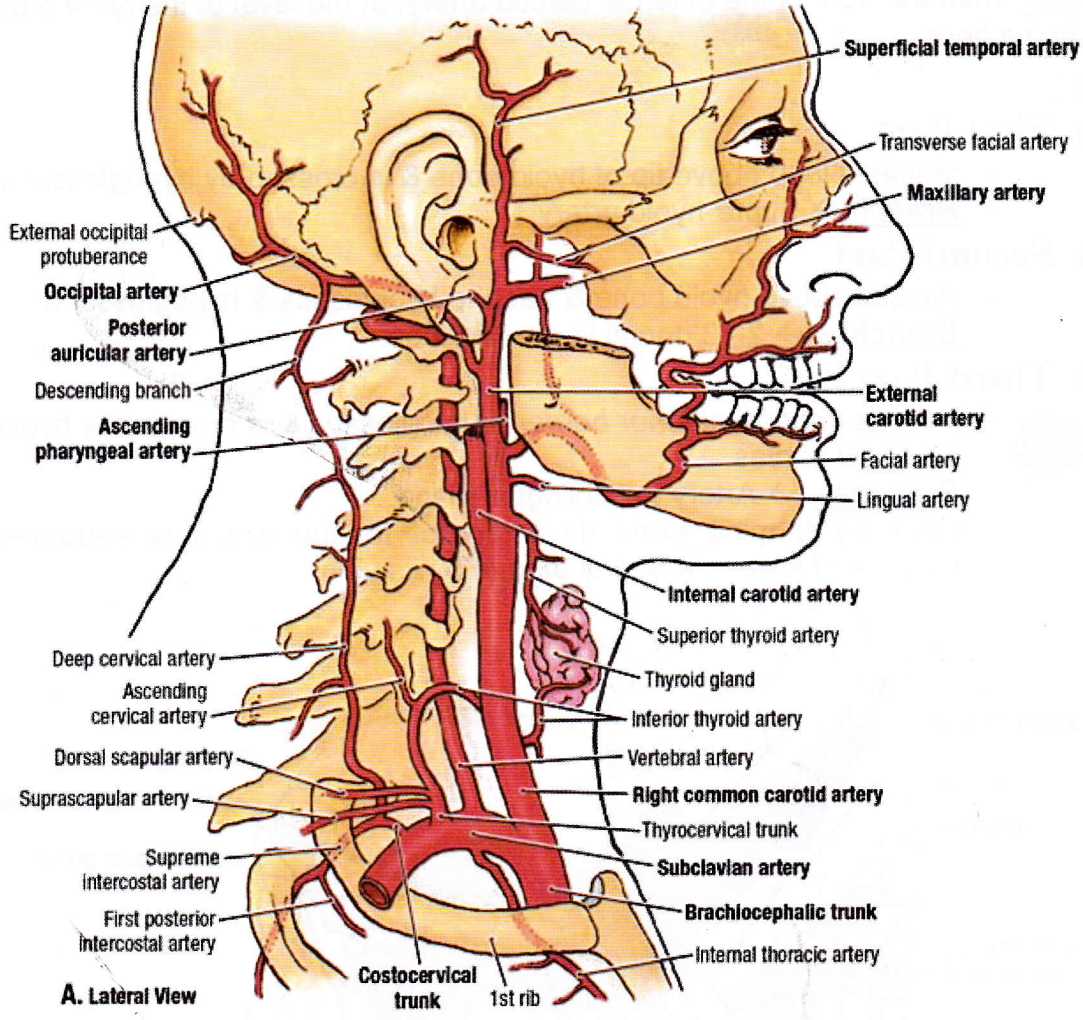
MCQ

1) Ophthalmic artery(it gives lacrimal & supraorbital As & ends by supratrochlear A & dorsal nasal A which anastomoses with facial A).
2) Anterior & middle cerebral arteries.
3) Posterior communicating & anterior choroid arteries.

Surgical Importance: A-V fistula between ICA & the cavernous sinus leading to throbbing pain and pulsating proptosis.

External Carotid Artery

Begins: From common carotid artery & passes outside carotid sheath.



Ends: At the level of neck of mandible inside parotid gland by dividing into superficial temporal & maxillary arteries.

Branches

1) ***From its medial aspect:*** ascending pharyngeal artery.
2) ***From its anterior aspect:***
   - Superior thyroid artery.
   - Lingual artery.
   - Facial artery.
3) ***From its posterior aspect:***
   - Occipital artery. MCQ
   - Posterior Auricular artery *(at the level of the upper border of posterior belly of digastric muscle).*
4) ***2 terminal branches:***
   - *Superficial temporal artery (called anesthetist's artery, as it is used to count pulse by anesthetists).* MCQ
   - Maxillary artery.

Surgical Importance:

In malignant goiter, obstruction of the carotid can occur. This causes loss or weakening of pulsation of the superficial temporal artery ***(Sign of Berry).***

Lingual Artery

Begins: from the front of the external carotid artery, at the level of the *tip of greater horn of hyoid bone*. MCQ

Parts:

1) First Part

- Makes a loop above tip of hyoid bone & is crossed by hypoglossal n.
- ***Branch*** → Supra-hyoid artery.

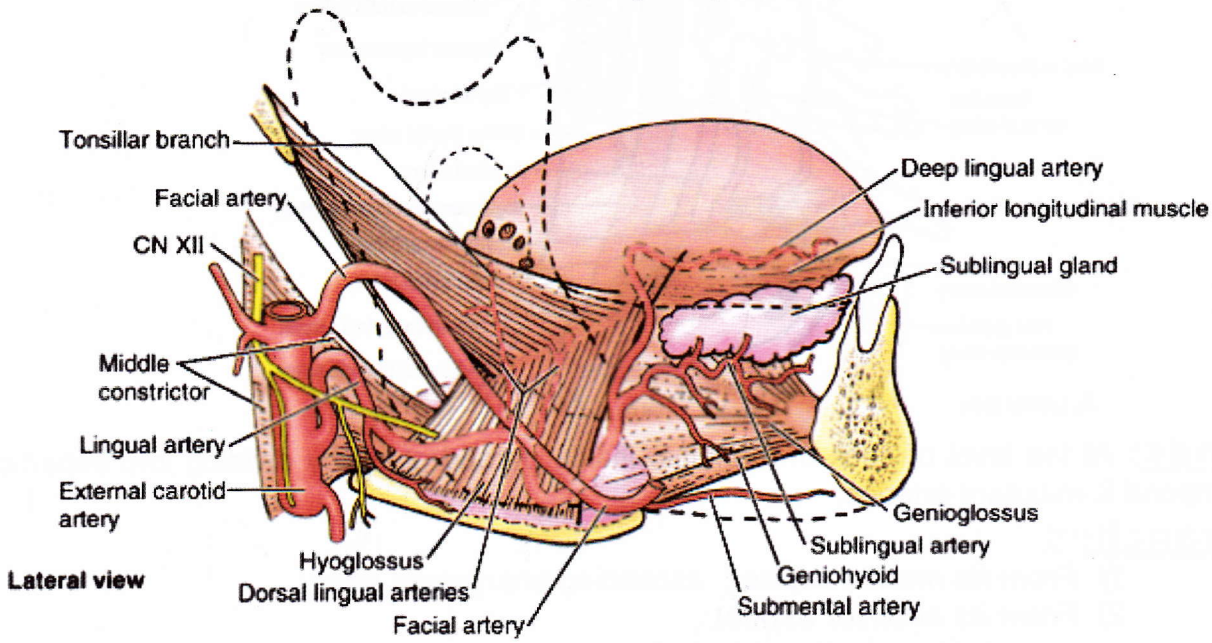
2) Second Part

- Passes above hyoid bone & deep to hyoglossus & hypoglossal n.
- ***Branches*** → 2 - 3 dorsal lingual arteries.

3) Third Part

MCQ

- Passes *deep to anterior border of hyoglossus* & is crossed by hypoglossal & lingual nerves.
- ***Branches*** → Artery to sublingual gland.
- Ends by forming profunda artery of tongue which is separated from mucosa of lower surface of tongue by its vein.



Surgical Importance:

- During tongue bleeding, we should pull tongue outwards as this causes compression on the lingual a. against the greater horn of hyoid bone.
- If it is mandatory to ligate the lingual a. It is better to ligate the 2nd part after cutting hyoglossus m. because the 1st part is related to hypoglossal nerve.

Facial Artery

Begins: from the front of ECA above the lingual artery.

Course:

MCQ

- *It ascends deep to the posterior belly of digastric & stylohyoid m. to reach the digastric triangle & runs deep to the submandibular gland.*
- It enters the face at the antero-inferior angle of the masseter and then it ascends in the face to reach the angle of the eye.

Surgical importance

- Should be double ligated during operation for submandibular salivary gland.

Anastomosis between internal & external carotid arteries

1. Angular A. (ECA) with branches of ophthalmic A (ICA).
2. Superficial temporal A. (ECA) with supraorbital & supratrochlear As (ICA).

Middle Meningeal Artery

Begins:

Branch of the **maxillary artery** deep to lateral pterygoid. MCQ

Course:

- Passes between the two roots of auriculo-temporal nerve, and then enters the middle cranial fossa by passing in foramen spinosum with nervus spinosus.
- In the cranial cavity the artery & its branches lie extra-dural.

Ends: In the middle cranial fossa. It divides into anterior & posterior divisions:

Anterior Division

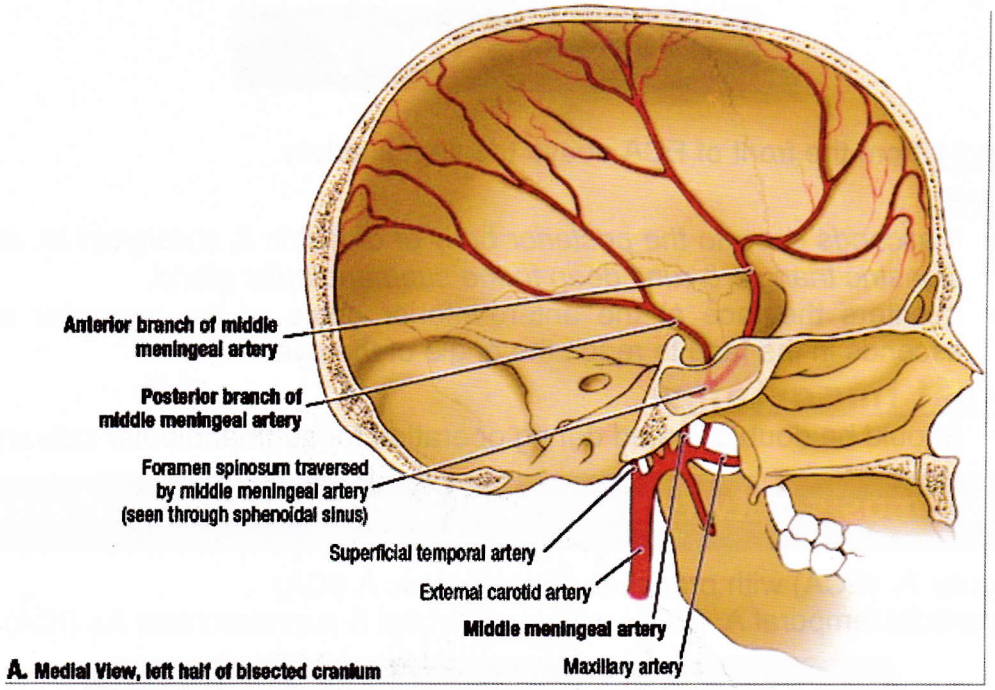
- Directed upwards & forwards towards the pterion, grooving the greater wing of sphenoid.
- Then passes upwards & backwards crossing to motor & sensory areas of the brain, towards a point 1cm behind coronal suture, grooving the parietal bone.
- It is the artery of extra-dural hemorrhage.

N.B. *Pterion is H-shaped suture between frontal, parietal, temporal & sphenoid bone. It is 4 cm above mid-zygomatic arch.*

Posterior Division

- Passes upwards & backwards towards the lambda grooving the temporal & parietal bones.

N.B. *It passes at the point of meeting of a horizontal line drawn from upper border of orbit & a vertical line drawn from post. border of mastoid process.*



A. Medial View, left half of bisected cranium

Surgical Importance: ***Extra-dural hemorrhage from:***
Diploic veins, dural venous sinuses or middle meningeal artery. MCQ

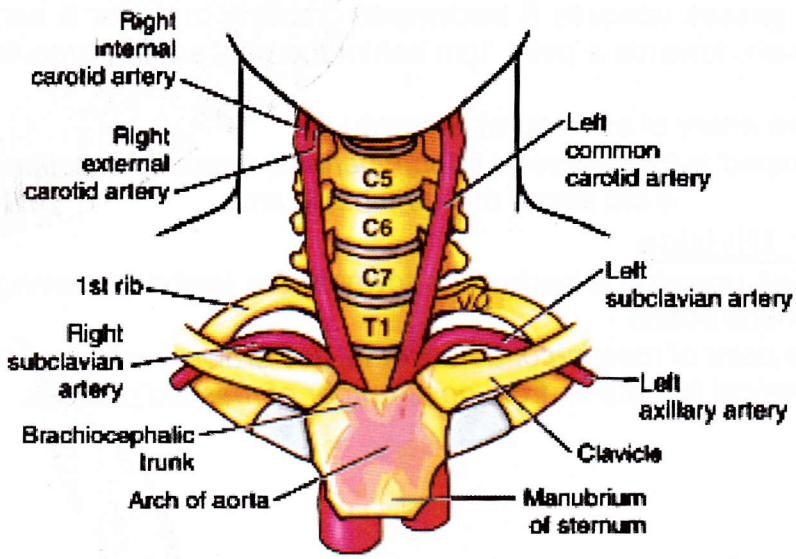
N.B: subdural hemorrhage is most likely due to rupture of cerebral vein

Subclavian Artery

Begins

1. The Rt. is a branch of innominate artery.
2. The Lt. is a branch of the arch of aorta.

Ends: At the outer border of the 1st rib by forming the axillary artery.



Divisions: scalenus anterior divides it into 3 parts; medial, behind & lateral.

Branches:

A- First part medial to scalenus anterior & gives 3 branches:

MCQ **1. *Internal mammary artery***

- It ends as superior epigastric & musculo-phrenic a.
- It is the artery usually chosen for coronary bypass operation.
- Branches:
  a. Upper 6 intercostal As.
  b. Anterior perforating As.
  c. Pericardiophrenic As.
  d. Mediastinal As.
  e. 2 terminal branches (superior epigastric & musculophrenic As).

2. *Vertebral artery*

Unites with its fellow at the lower border of pons to give basilar artery (then to circle of Willis).

3. *Thyro-cervical trunk,* which gives:

a) Inferior thyroid artery (to thyroid gland).

Surgical Importance:

In thyroidectomy, this artery should be ligated in continuity to avoid dropping in the thorax which might necessitate thoracotomy to stop bleeding.

b) Supra-scapular artery.

c) Transverse cervical artery.

B- Second part: deep to scalenus anterior

It gives **costo-cervical trunk**, which gives:

1. Superior intercostal artery which gives the upper 2 intercostal arteries (the rest of intercostal arteries arise from aorta).
2. Deep cervical artery.

C- Third part

Lateral to scalenus anterior, usually gives no branches rarely gives descending cervical artery that share in anastomosis around scapula.

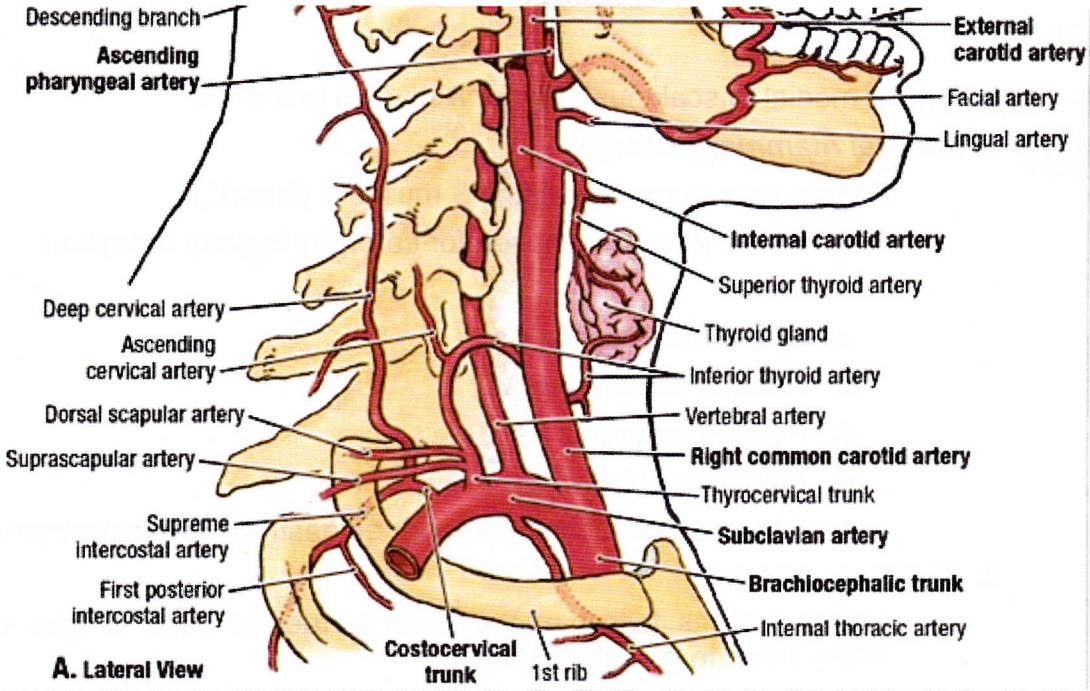
Relations:

Anterior:

- 1st part: carotid sheath, phrenic nerve, sternomastoid, infra-hyoid muscles and RLN on the right side.
- 2nd part: scalenus anterior muscle.

Posterior:

- 3rd part: lower trunk of the brachial plexus & 1st rib, separated from the cervical pleura by supra-pleural membrane (fibrous sheet attached to C_7 & inner border of the 1st rib = Sibson's fascia).



Surgical Importance:

Exposure:

- Median sternotomy.
- 1 cm above the clavicle extending from the supra-sternal notch about 10 cm laterally.

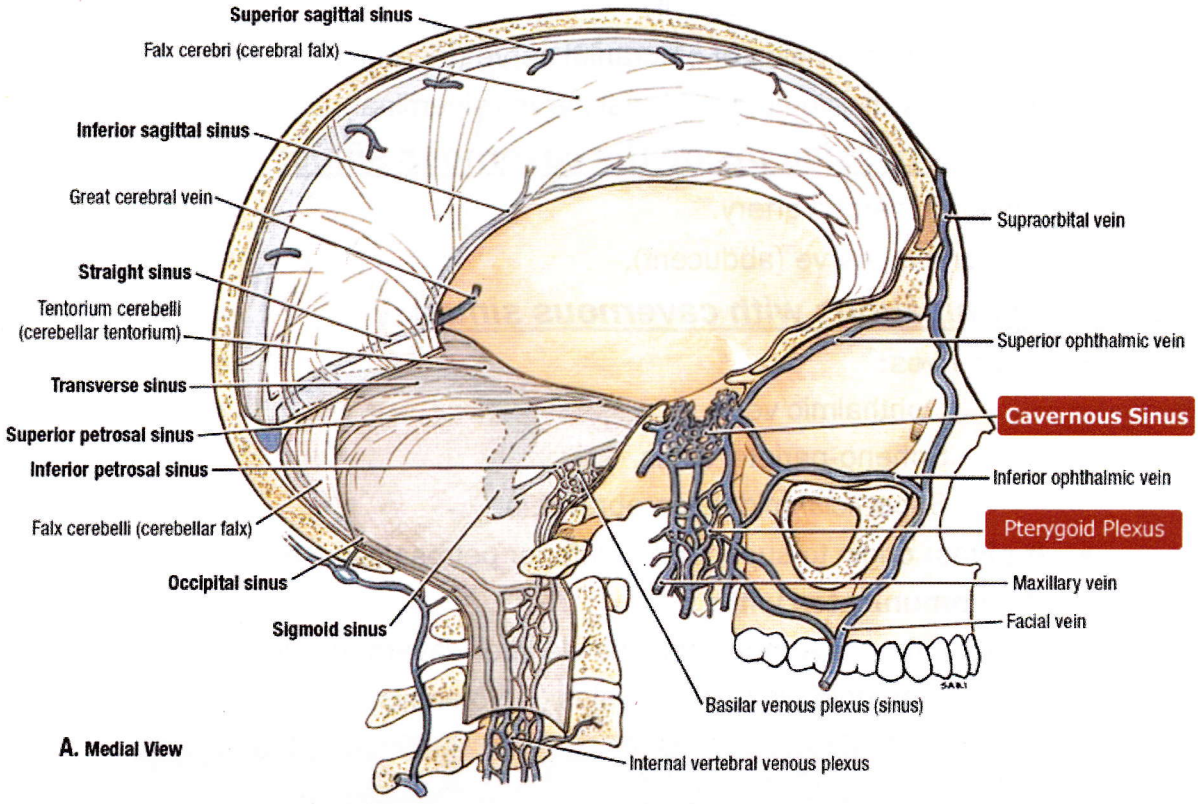
Compression:

- The Rt. subclavian artery arises from descending aorta & passes posterior to the trachea & esophagus. The aberrant artery is usually asymptomatic but may cause dysphagia (dysphagia lusoria).
- Compression of the subclavian artery by the cervical rib may result in an aneurysm, which is a potential source of emboli to the hand. Because of the good collateral circulation, critical ischemia is rare, but the patient will complain of chronic ischemia of upper limb.

Obstruction:

- Proximal to vertebral artery: vertebral a. acts as collateral to the arm & steals flow from the basilar artery **(subclavian steal syndrome)**.
- At the 3rd part: collaterals are formed with the intercostal anastomosis (costo-cervical trunk with branches of the axillary artery) in addition to anastomosis around the scapula (transverse cervical branch from 1st part with sub-scapular & circumflex humeral branches of the axillary artery).

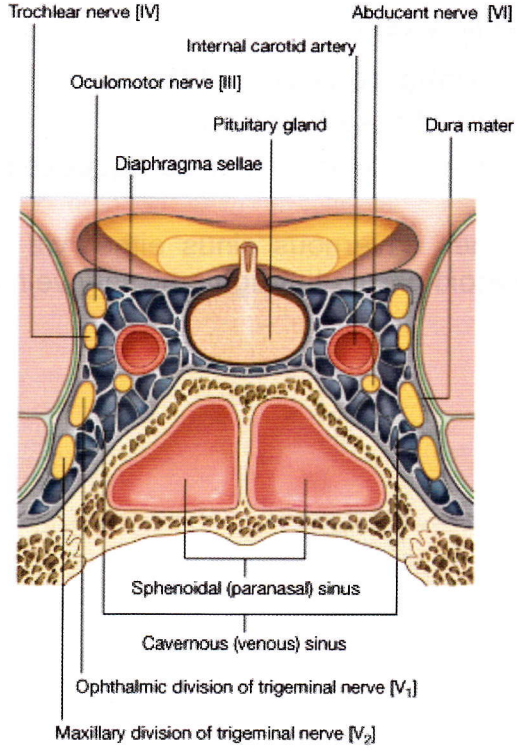
Veins of Head & Neck



Cavernous Sinus

2 sinuses on each side of the hypophyseal fossa → pituitary gland (hypophysis cerebri medial to it).

MCQ



1) Structures in its lateral wall:

MCQ

- **3rd cranial nerve (oculo-motor).**
- 4th cranial nerve (trochlear).
- Ophthalmic division of 5th cranial nerve (trigeminal).
- Maxillary division of 5th cranial nerve (trigeminal).

2) Structures passing inside the cavernous sinus:

MCQ

- Internal carotid artery.
- 6th cranial nerve (abducent).

3) Communications with cavernous sinus:

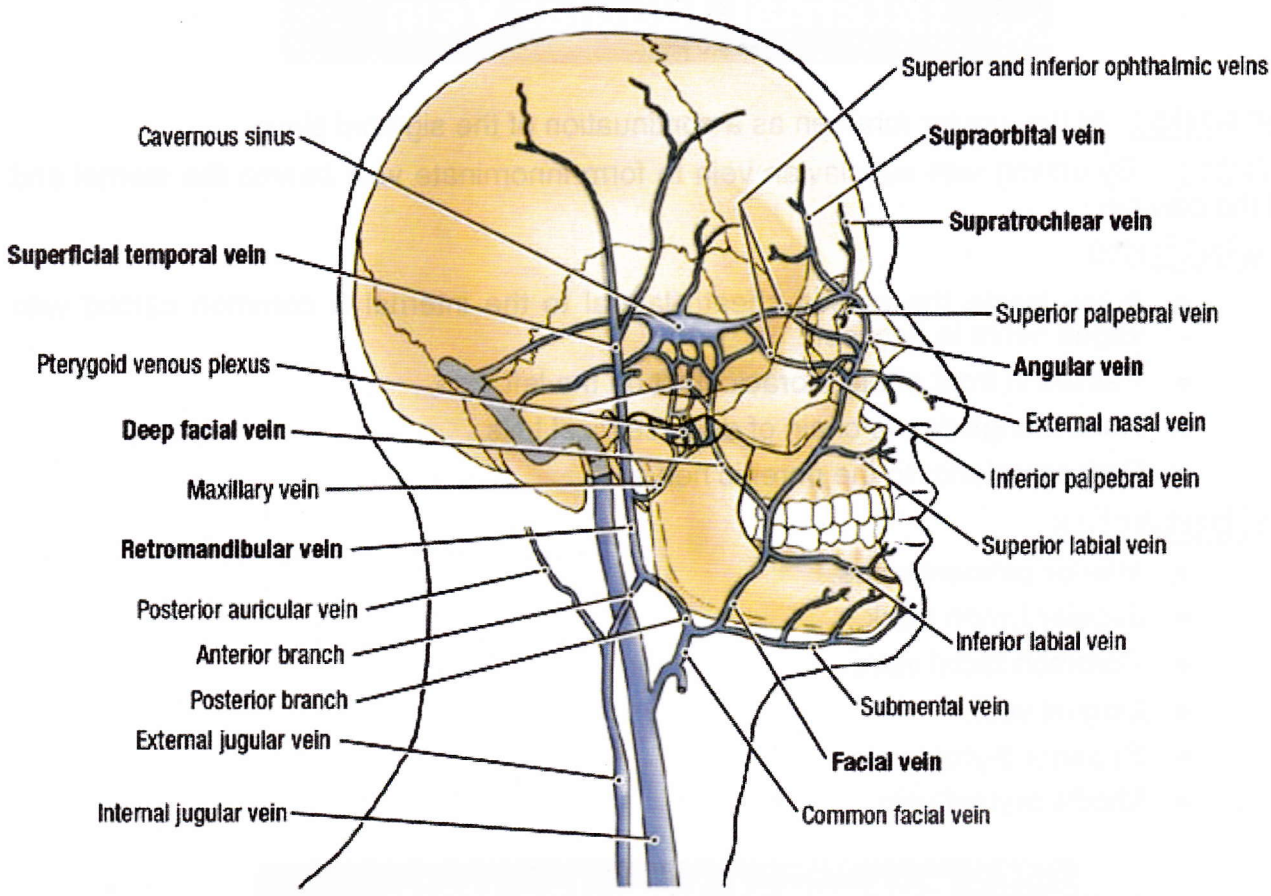
- **It receives:**
  - Ophthalmic vein.
  - Spheno-parietal sinus.
  - Superficial middle cerebral vein.
- **It gives:** origin to superior and inferior petrosal sinuses.
- **It communicates with:**
  - Other cavernous sinuses via inter-cavernous sinuses.
  - Pterygoid plexuses of veins (via 3 emissary veins).

Pterygoid Plexus of veins

- It is present around the lateral pterygoid muscle.
- It communicates with inferior ophthalmic vein, anterior facial vein and cavernous sinus (via 3 emissary veins).
- These veins have no valves; draining the dangerous area of face and can cause cavernous sinus thrombosis.
- It is drained by the maxillary vein.

Surgical Importance: Dangerous area of the face

- The area formed of nose & upper lip.
- Any infection even boil must not be squeezed for fear of cavernous sinus thrombosis.
- Infection reaches cavernous sinus either via ophthalmic emissary vein or reaches pterygoid plexus through emissary vein in foramen lacerum.



Anterior Facial vein

- Formed by the union of supra-trochlear & supra-orbital veins.
- Ends by joining anterior division of posterior facial vein to form the common facial vein, which ends in internal jugular vein.

NB: ***Superior thyroid vein may end in the common facial vein 50%.***

Posterior Facial vein

- Formed inside parotid gland by union of superficial temporal & maxillary veins.
- <u>Ends by giving:</u>
  1) Anterior division → ends in common facial vein.
  2) Posterior division → joins posterior auricular vein to form external jugular vein which ends in the subclavian vein.

Deep Facial vein

It connects anterior facial vein with pterygoid plexus of veins.

Internal Jugular Vein

Begins: At the jugular foramen as a continuation of the sigmoid sinus.

Ends: By uniting with subclavian vein to form innominate vein behind the sternal end of the clavicle.

Relations

- It lies inside the carotid sheath lateral to the internal & common carotid with vagus nerve in between.
- Passes in front of the thoracic duct on the left side.
- Runs alongside the chain of deep cervical LNs.
- Passes anterior to the phrenic nerve.

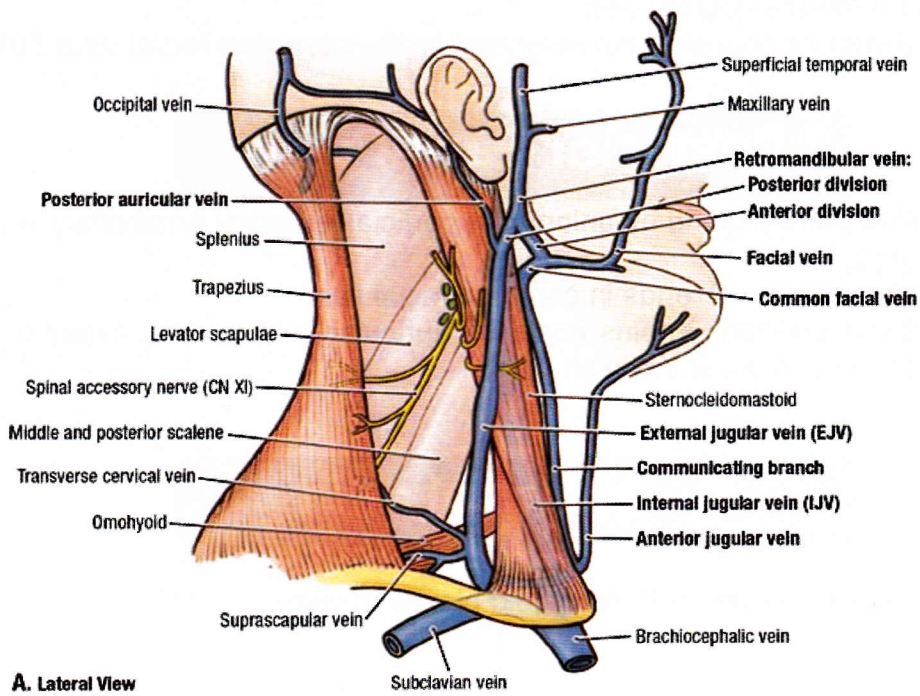
Tributaries

- Inferior petrosal sinus.
- Jugular lymph trunk.
- Common facial vein.
- Lingual vein.
- Superior thyroid vein.
- Middle thyroid vein.

External Jugular Vein

MCQ

- It is formed by union of posterior auricular vein & retro-mandibular vein.
- It crosses perpendicular to the superficial surface of the sternomastoid beneath the platysma muscle.
- It is a tributary of subclavian vein.



A. Lateral View

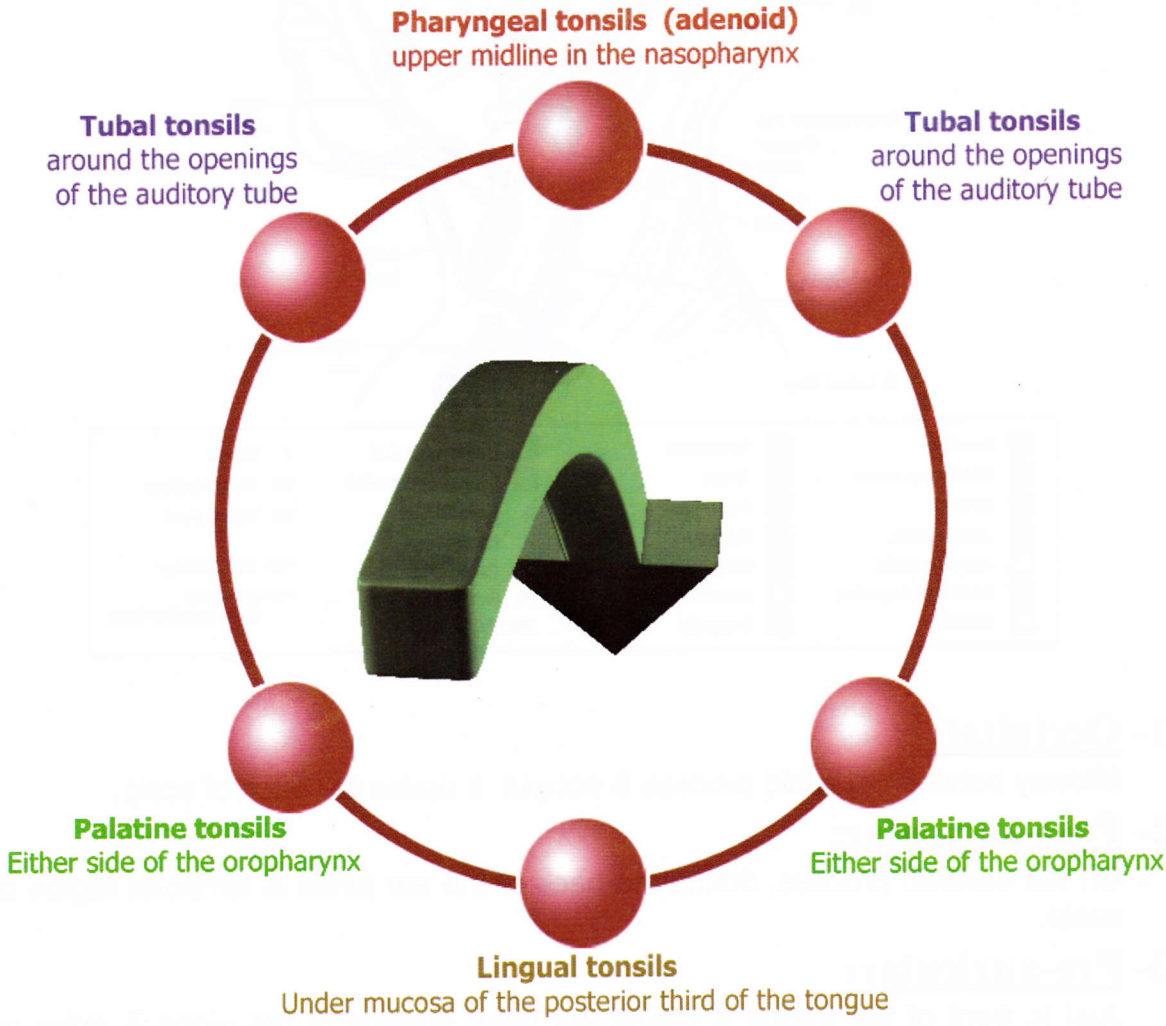
Lymphatics of Head & Neck

The Ring of Waldeyer

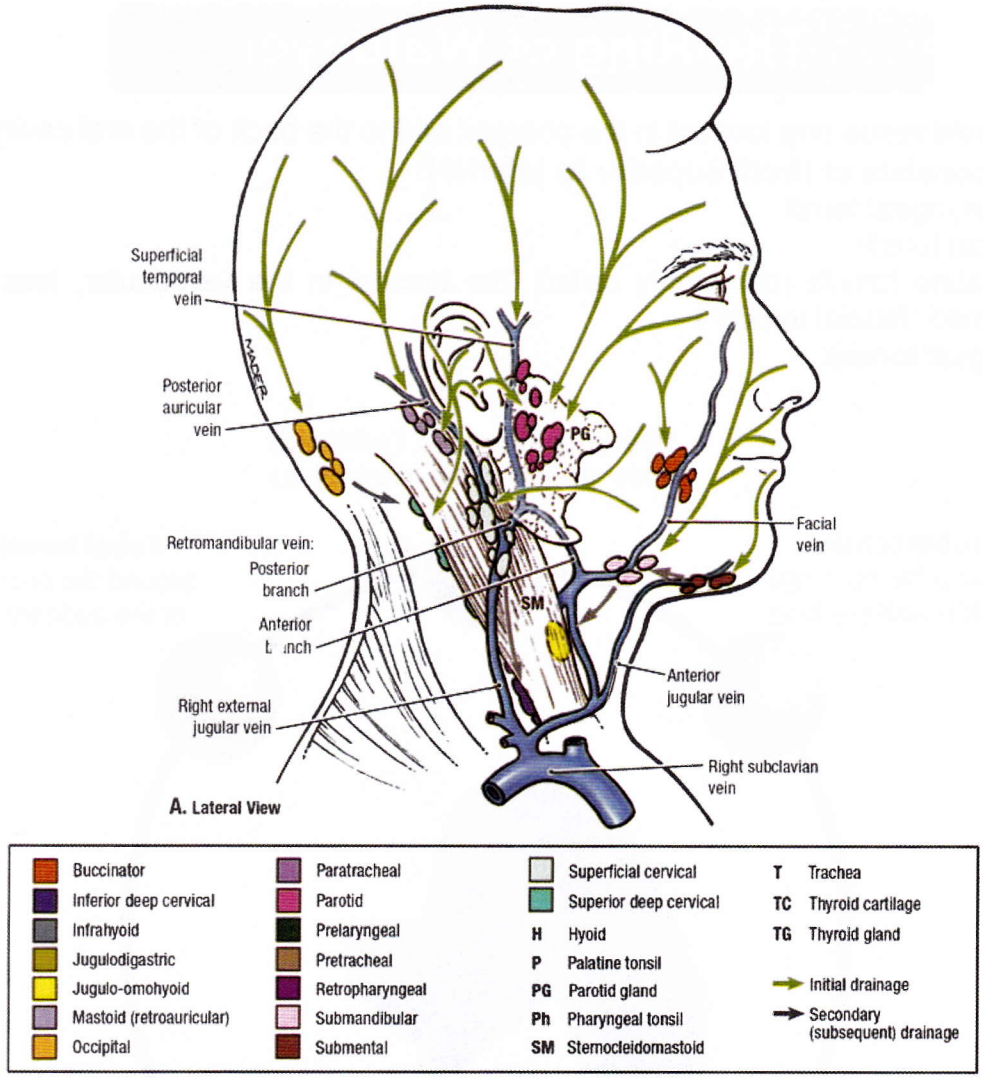
The lymphoid tissue ring located in the pharynx and to the back of the oral cavity.

The ring consists of (from superior to inferior):

- Pharyngeal tonsil.
- Tubal tonsils.
- Palatine tonsils (commonly called "the tonsils" in the vernacular, less commonly termed "faucial tonsils").
- Lingual tonsils.



The Circular Chain



1- Occipital:

Midway between mastoid process & occiput. It drains the back of scalp.

2- Post-auricular:

On the mastoid process, drains the back of the ear pinna & temporal region of the scalp.

3- Pre-auricular:

Just in front of the tragus & drains the outer surface of the pinna & sides of the scalp.

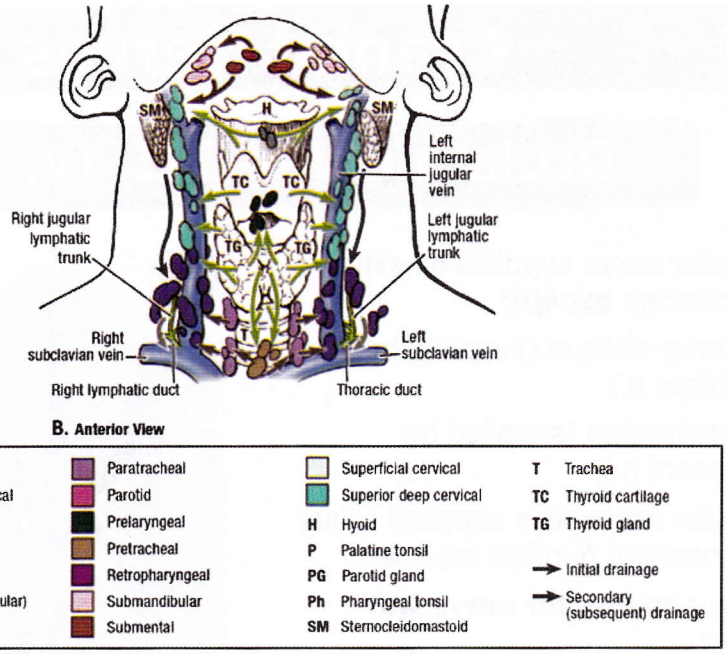
4- Submandibular:

Drains the upper lip, angle of the mouth, lateral part of the lower lip & the tongue.

5- Submental:

Drains middle part of lower lip, tip of the tongue & floor of the mouth.

Longitudinal Chain



A- Superficial Cervical

MCQ

Runs with *external jugular vein* draining the parotid & lower part of ear.

B- Deep Cervical Group

MCQ

- ***Upper & lower deep cervical LNs*** are related to the internal jugular vein & separated from each other by omohyoid muscle.
- ***The upper deep cervical group has two groups:***
  1- Jugulo-digastric which drains the tonsils.
  2- Jugulo-omohyoid which drains the tip of the tongue.
- ***The efferent from the deep cervical LNs goes to***
  - Rt. Side → jugular duct & subclavian lymph trunk.
  - Lt. Side → thoracic duct.

Lymph Drainage of the Tongue	Lymph Drainage of Lips
Anterior ⅔ • Tip → sub-mental → jugulo-omohyoid LNs. • Sides → ipsilateral submandibular LNs. • Middle → submandibular on both sides. ***Posterior ⅓*** Deep cervical LNs (1st, retro-pharyngeal LNs → deep cervical lymph nodes).	***Upper lip*** → Both submandibular LNs. ***Lower lip:*** •Middle part → submental LNs. •Lateral parts → submandibular LNs.

N.B: **The lymph drainage of the head & neck finally**

MCQ

- On the left side → jugular lymph trunk → thoracic duct.
- On the right side → right jugular or subclavian vein.

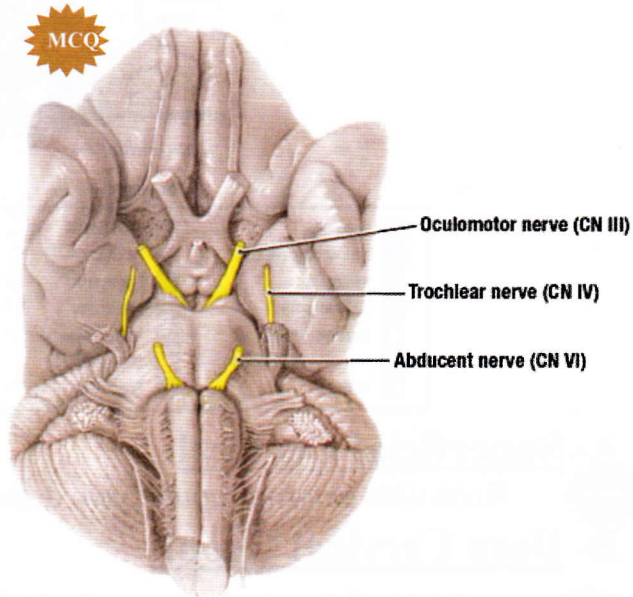
Nerves of Head & Neck

Cranial Nerves

Ocular nerves (III, IV, VI)

- Oculomotor nerve supplies all extra-ocular muscles ***except:***
  - Superior oblique (supplied by trochlear n.)
  - Lateral rectus (supplied by abducent n.)
- Oculomotor nerve also supplies ciliary ms & constrictor pupillae muscle.
- **Injury to oculomotor nerve will oduce:** MCQ
  - Dilatation of pupil.
  - Ptosis.
  - Lateral squint.
  - Loss of accommodation.

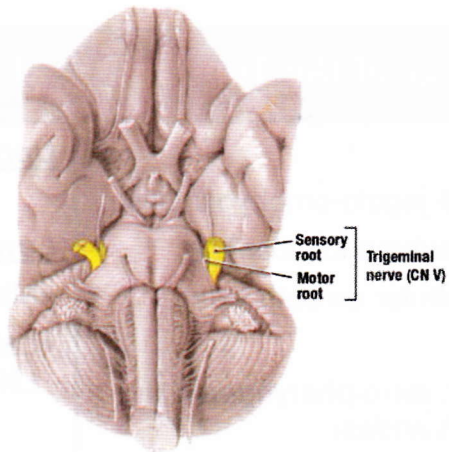
MCQ

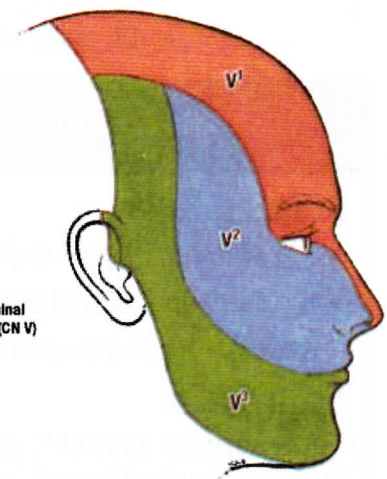


N.B: Herniation of the uncus of temporal lobe through the tentorial notch → pressure on the oculomotor **nerve**. MCQ

The Trigeminal Nerve (V)

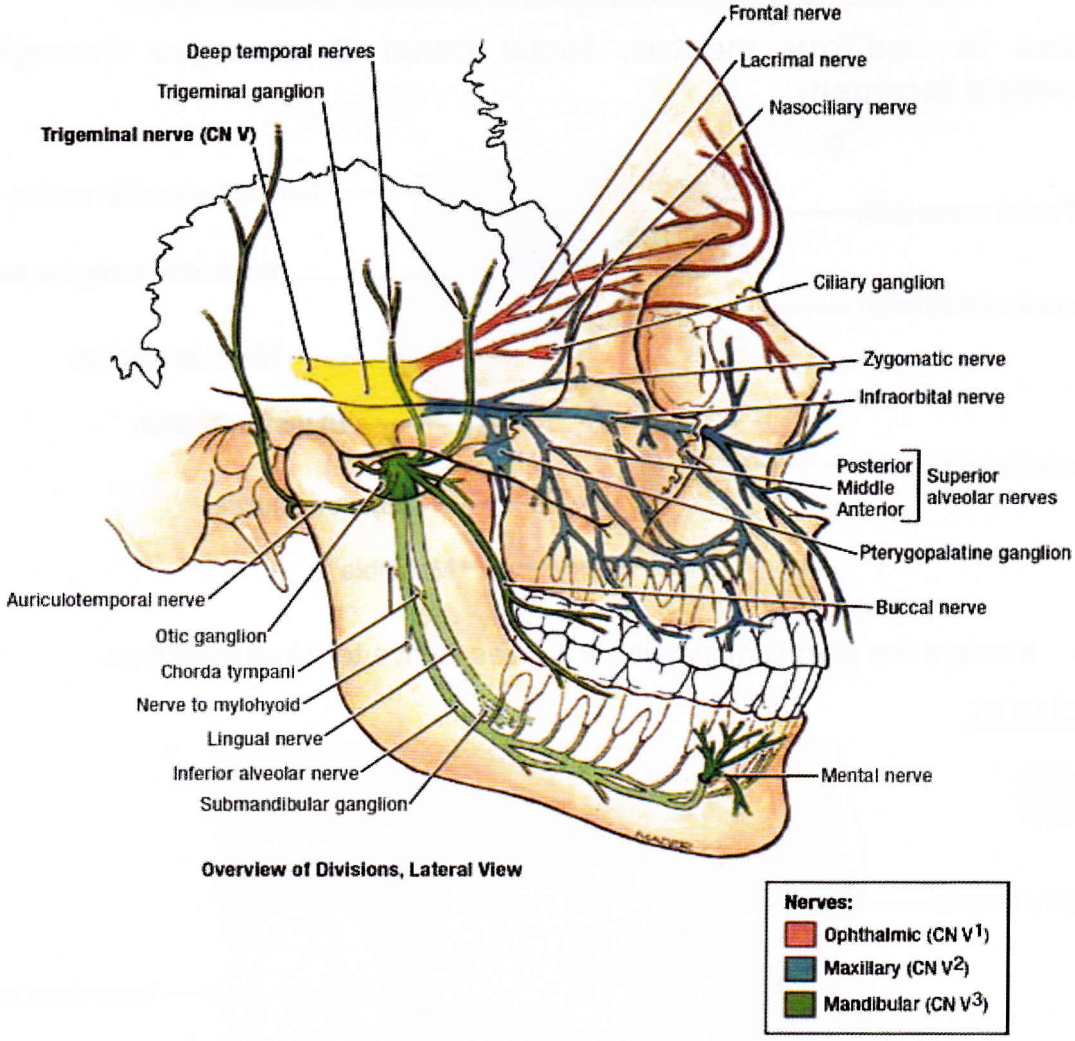
- It is the 5th cranial nerve.
- It is a mixed nerve, gives 2 sensory nerves & the mandibular nerve.
- ***Two sensory nerves***
  - The ophthalmic nerve.
  - The maxillary nerve.





...ous Innervation, Lateral View

The Mandibular Nerve



It is a mixed nerve, passes in foramen ovale and gives:

1. **Nerve to medial pterygoid** (this also supplies the tensor palati muscle).
2. **Nervus spinosus.** MCQ
3. **Anterior division:**
   - Which supplies masseter, temporalis & lateral pterygoid **i.e. it supplies the 4 muscles of mastication**. MCQ
   - It gives buccal branch (sensory to cheek).
4. **Posterior division, which gives**
   - **Auriculo-temporal nerve**. MCQ
   - **Lingual nerve.** It gives:
     - -General sensation to the mucosa of anterior ⅔ of the tongue.
     - -Secretomotor fibers to sublingual glands.
   - **Inferior alveolar nerve**, which supplies the lower teeth and ends as mental nerve.

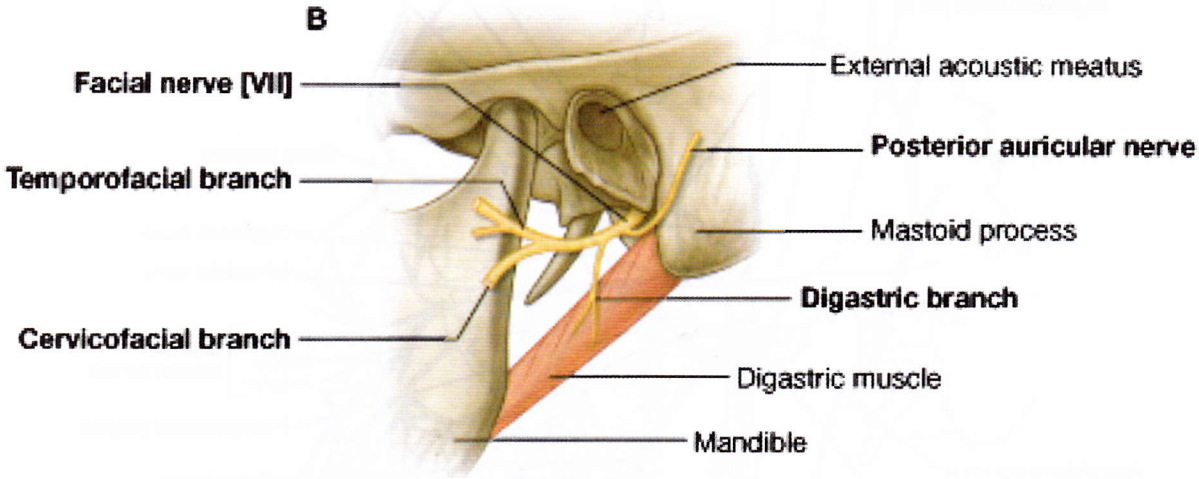
Mental nerve passes through the mental foramen which is located between the lower 1st & 2nd premolars

- Gives **mylohyoid nerve** to supply *mylohyoid & anterior belly of digastric.*

Mandibular nerve passes in the foramen ovale & does not pass through mandibular foramen

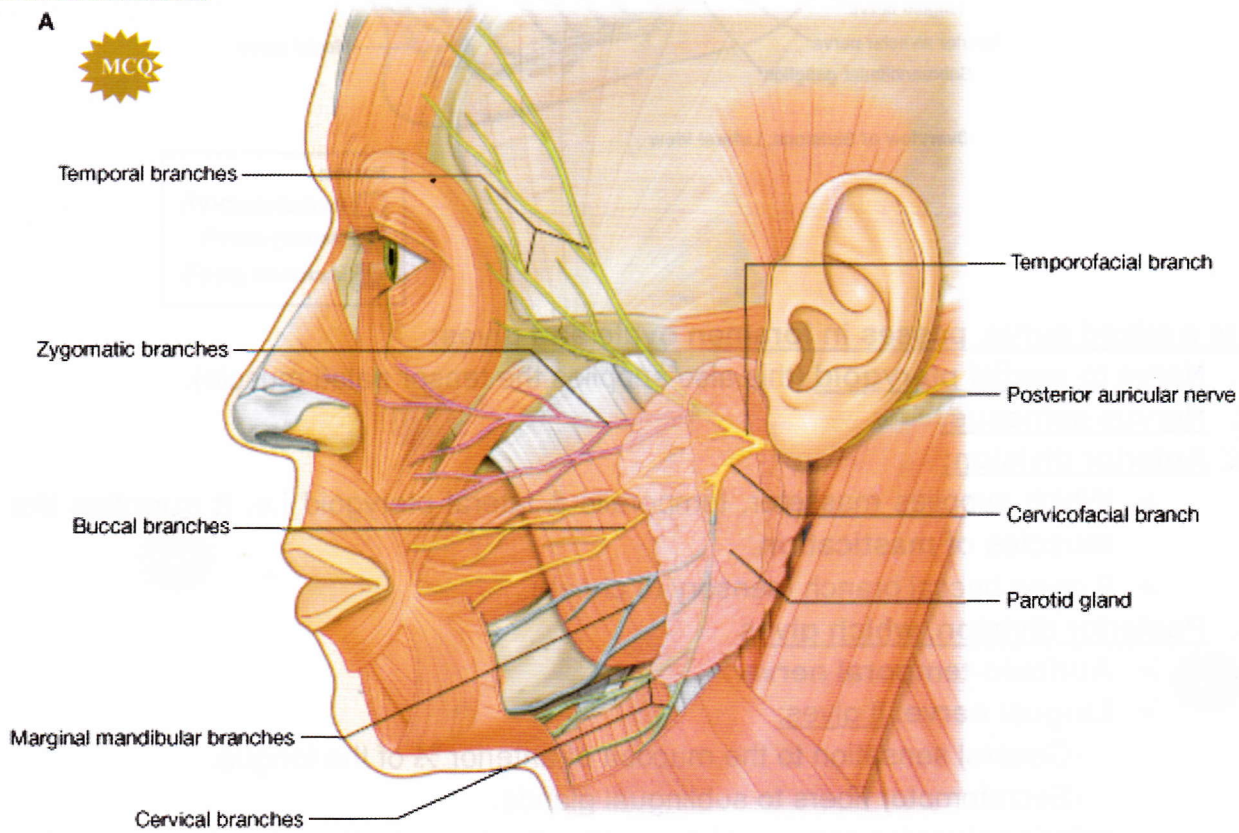
The Facial Nerve (VII)

It passes in auditory meatus, facial canal & emerges through the stylomastoid foramen.



- It enters the parotid gland where it gives its five terminal branches.

Branches:



In facial canal it gives:

1) Greater superficial petrosal
2) ***Chorda tympani:***

MCQ

- Passes through tympanic cavity & petro-tympanic fissure.
- Carries taste sensation from the ant ⅔ of the tongue.

3) Nerve to stapedius muscle.

Just after its exit from stylomastoid foramen it gives:

1) Nerve to stylohyoid.
2) Nerve to *posterior belly of digastric.*

5 terminal branches (inside the parotid gland):

1) Temporal.
2) Zygomatic.
3) Buccal.
4) Mandibular.
5) Cervical *(which supplies the platysma).*

MCQ ***N.B:*** ***Facial nerve lesion → inability to suck liquids through a straw.***

MCQ Glossopharyngeal Nerve (IX)

- It supplies all types of sensations (general & taste) to mucosa of the posterior ⅓ of the tongue.
- It supplies stylo-pharyngeus muscle (the only muscle supplied by it).

Vagus Nerve (X)

- It is the longest cranial nerve.
- ***Branches***: see above.

Accessory Nerve (XI)

Cranial part:

- ***Origin***: Nucleus Ambiguous in medulla oblongata.
- ***Joins*** the vagus n. & distributed along its pharyngeal & laryngeal branches.
- MCQ ***It supplies*** all muscles of the soft palate *except* tensor palati (which is supplied by mandibular nerve).

Spinal part:

- ***Origin***: upper 6 cervical segments.
- ***Supplies*** sternomastoid & trapezius.

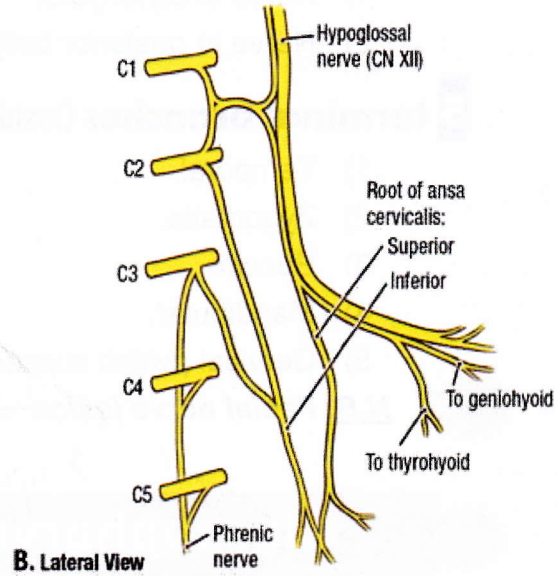
MCQ Hypoglossal Nerve (XII)

It supplies the intrinsic muscles of the tongue and the extrinsic muscles which are (hyoglossus, styloglossus, genioglossus & palatoglossus).

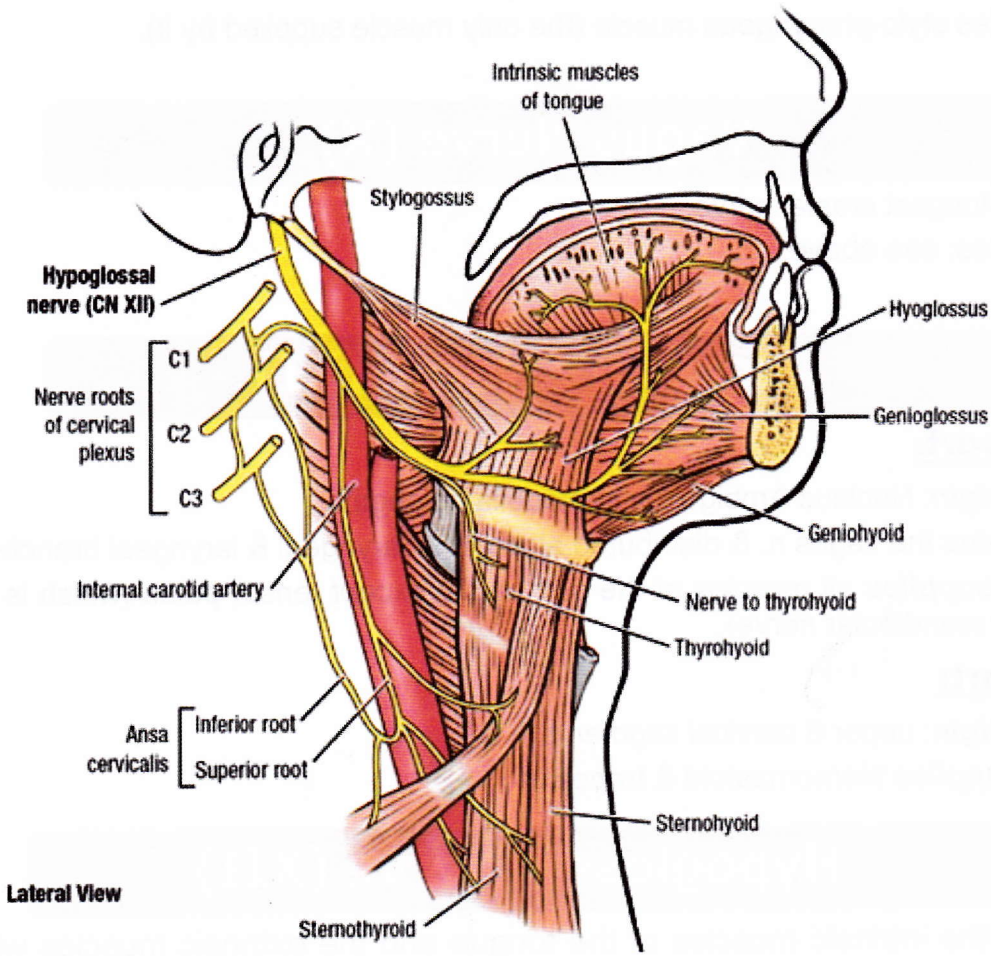
Ansa cervicalis

- Nerves that contribute to its formation: C1, C2, C3.
  - -Descedens hypoglossi C1
  - -Descendens cervicalis C2, C3
- Muscles supplied: sternothyroid, sternohyoid, omohyoid.

  NB: Thyrohyoid is supplied by C1 directly.

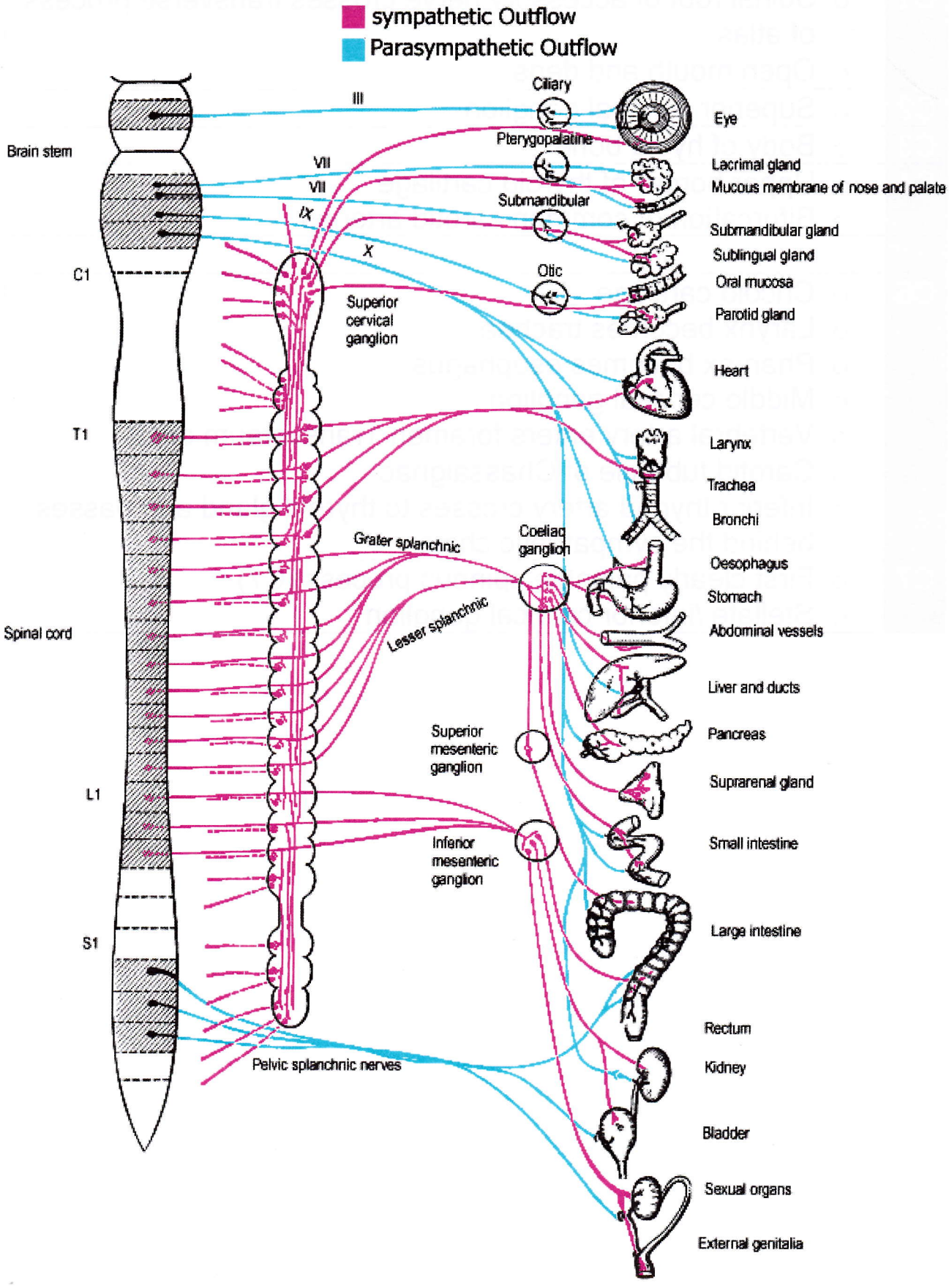


B. Lateral View



Lateral View

Autonomic Nervous System



Vertebral levels of the structures

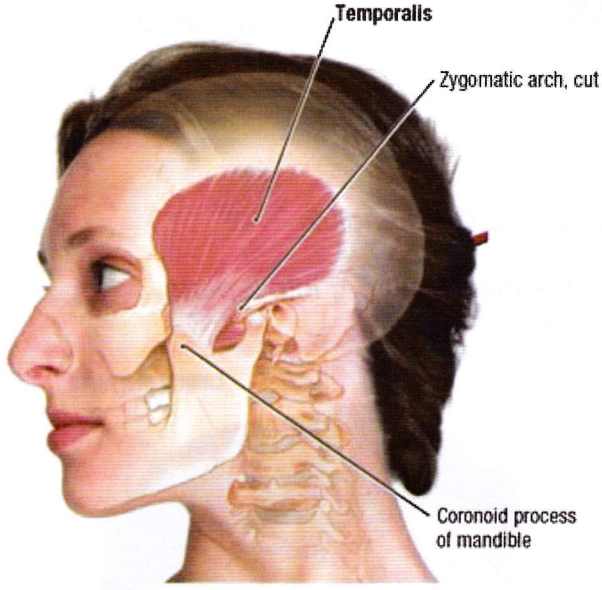
C1	○ Spinal root of accessory nerve crosses transverse process of atlas ○ Open mouth and dens
C2	○ Superior cervical ganglion
C3	○ Body of hyoid bone
C4	○ Upper border of thyroid cartilage ○ Bifurcation of common carotid arteries
C6	○ Cricoid cartilage ○ Larynx becomes trachea ○ Pharynx becomes esophagus ○ Middle cervical ganglion ○ Vertebral artery enters foramen Transversum of C6 ○ Carotid tubercle of Chassaignac ○ Inferior thyroid artery crosses to thyroid gland and passes behind the sympathetic chain
C7	○ First clearly palpable spinous process (C7) ○ Stellate /inferior cervical ganglion

Muscles of Head & Neck

Muscles of Mastication

Temporalis

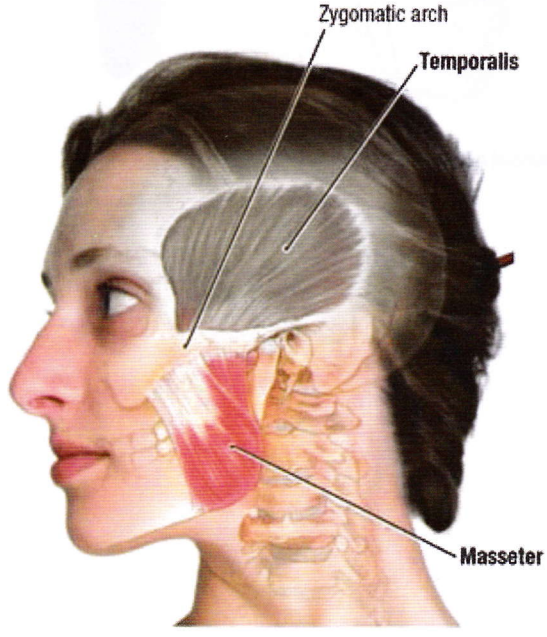
Origin	Insertion	N. Supply	Action
Temporal fossa of the skull	Coronoid process of the mandible	Anterior division of the mandibular nerve	Elevates & retracts mandible



Masseter

MCQ

Origin	Insertion	N. Supply	Action
Zygomatic arch of the maxilla	Outer surface of ramus of mandible	Anterior division of mandibular nerve	Elevates & protrudes mandible



Lateral Pterygoid MCQ

Origin	Insertion	N. Supply	Action
Greater wing of sphenoid & lateral pterygoid plate	Neck of mandible	Anterior division of mandibular nerve	Lowers mandible Side to side movement (chewing)

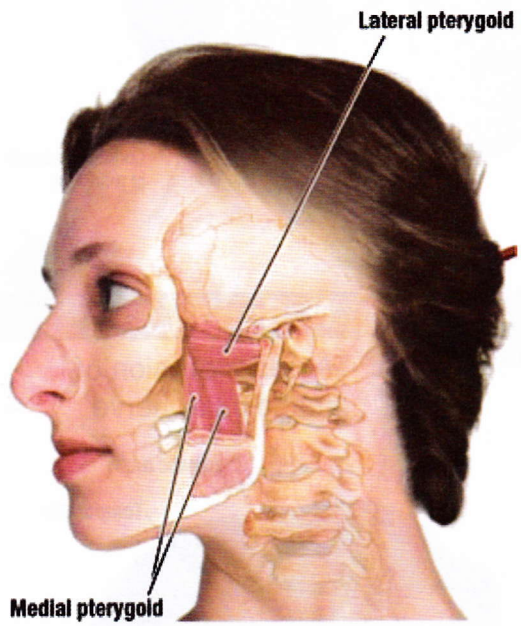
Medial Pterygoid MCQ

Origin	Insertion	N. Supply	Action
Maxillary tuberosity & lateral pterygoid plate	Inner surface of ramus of mandible	Main trunk of mandibular n.	Elevates mandible Side to side movement

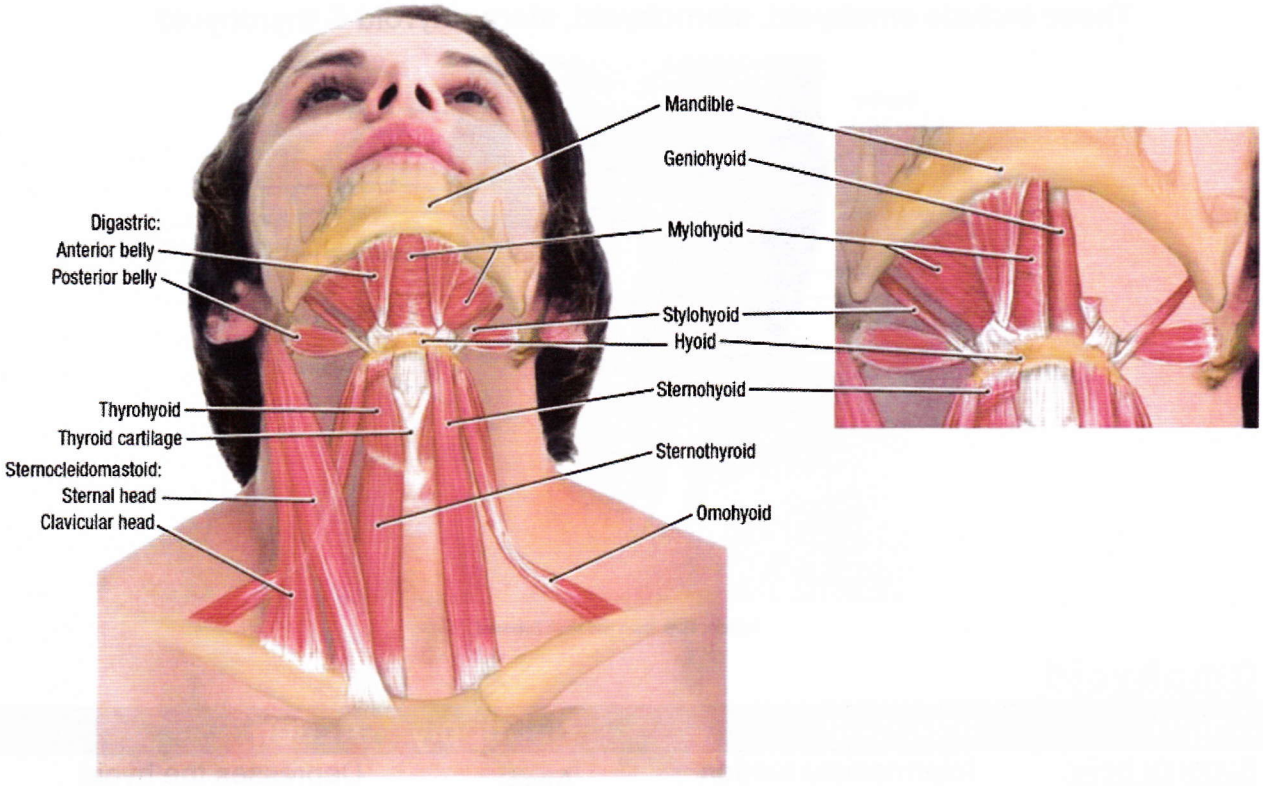
N.B:

- Both muscles together protrude the mandible. MCQ

- Lateral pterygoid divides the mandibular A. into 3 parts



Supra-hyoid Muscles



Anterior View, Head and Neck Extended

MCQ

Digastric muscle

Origin	Insertion	N. Supply	Action
Anterior belly: digastric fossa of mandible **Posterior belly**: medial surface of the mastoid process	Intermediate tendon connected to hyoid bone	Anterior belly: mandibular nerve. Posterior belly: facial nerve	▪ Depression of the mandible ▪ Elevation of the hyoid bone

Mylohyoid muscle

It forms the floor of the mouth

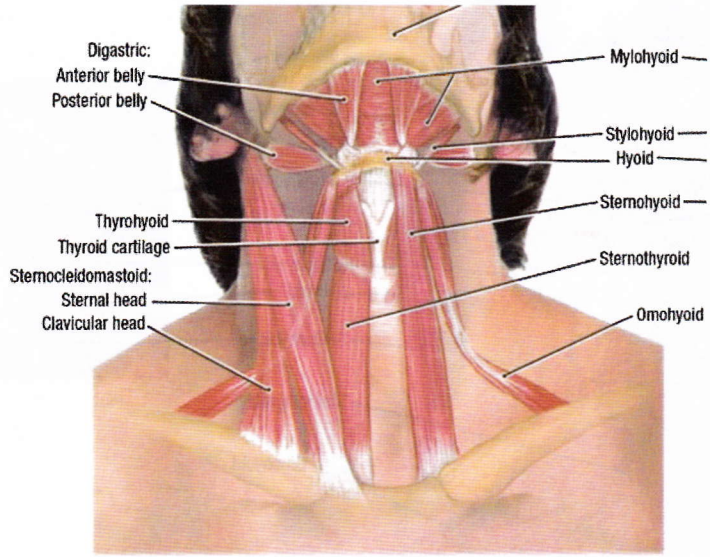
MCQ

Origin	Insertion	N. Supply	Action
Mylohyoid line of the mandible	Median raphe & body of hyoid bone	Nerve to mylohyoid (from mandibular n.)	▪ Depression of mandible ▪ Elevation of hyoid bone

MCQ

Infra-hyoid Muscles

These include omohyoid, sternohyoid, sternothyroid & thyrohyoid



Anterior View, Head and Neck Extended

Omohyoid

Origin	Insertion	N. Supply	Action
Superior belly: body of hyoid bone Inferior belly: upper border of the scapula	Intermediate tendon connected to clavicle by fibrous sling	Ansa cervicalis ($C_{1,2,3}$)	Depresses the hyoid bone in the 2nd phase of deglutition

Sternohyoid

Origin	Insertion	N. Supply	Action
Back of manubrium	Body of hyoid bone	Ansa cervicalis ($C_{1,2,3}$)	Depresses the hyoid bone in the 2nd phase of deglutition

Sternothyroid

Origin	Insertion	N. Supply	Action
Back of manubrium	Oblique line of the thyroid cartilage	Ansa cervicalis ($C_{1,2,3}$)	Depresses the hyoid bone in the 2nd phase of deglutition

Thyrohyoid

Origin	Insertion	N. Supply	Action
Oblique line of thyroid cartilage	Hyoid bone	C_1	Depresses the hyoid bone in the 2nd phase of deglutition

Sternomastoid

Origin	Insertion	N. Supply	Action
Sternal head: Manubrium sterni *Clavicular head:* clavicle	Mastoid process	Spinal accessory n	2 muscles: flexes the neck 1 muscle: bends the head to the same side & turns the face to the opposite side

Surgical importance

- Examination of cervical LNs.
- Determination of the relation of neck swellings to it.
- Boundaries in anterior & posterior triangles of yhe neck.

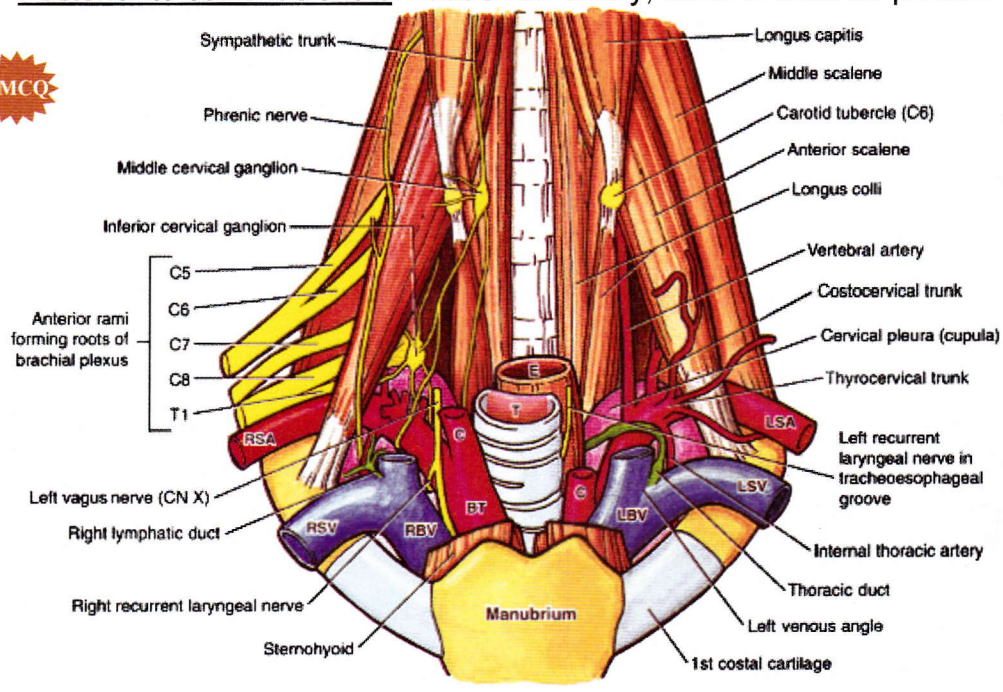
Scalenus Anterior

Origin	Insertion	N. Supply	Action
Anterior tubercles of transverse processes of C3,4,5,6	Scalene tubercle of 1st rib	Anterior 1ry rami of C4,5,6	Flexion of neck Elevation of the 1st rib

Relations of scalenus anterior:

- *Anterior to scalenus anterior is*: subclavian vein, phrenic nerve.
- *Posterior to scalenus ant is*: subclavian artery, roots of brachial plexus.

MCQ



A Anterior view

Anterior	Medial
▪ Phrenic N. (under pre-vertebral fascia) ▪ Ascending cervical fascia. ▪ Transverse cervical/supra-scapular artery ▪ Carotid sheath ▪ Vagus ▪ Thoracic duct ▪ Lower belly of omohyoid ▪ Deep cervical nodes	▪ Longus coli ▪ Carotid tubercle ▪ Pyramidal space ▪ Carotid sheath ▪ Stellate ganglion ▪ Vertebral artery ▪ Middle cervical artery ▪ Inferior thyroid artery ▪ 2st part subclavian artery ▪ Ansa cervicalis ▪ Thyro cervical trunk ▪ Vertebral vein
Posterior	**Lateral**
▪ 2nd part of subclavian artery ▪ Anterior rami C3-T1 ▪ Costo-cervical trunk ▪ Superior intercostal and deep cervical arteries ▪ Scalenus medius	▪ Trunk of brachial plexus ▪ 3rd part of subclavian artery

CHAPTER 2

UPPER LIMB

The function of the upper limb is to place the hand in position to be effective as a grasping tool. As such, the upper limb has adapted into a body part with great freedom of motion. Muscles that control this motion extend across the back and thorax.

UPPER LIMB

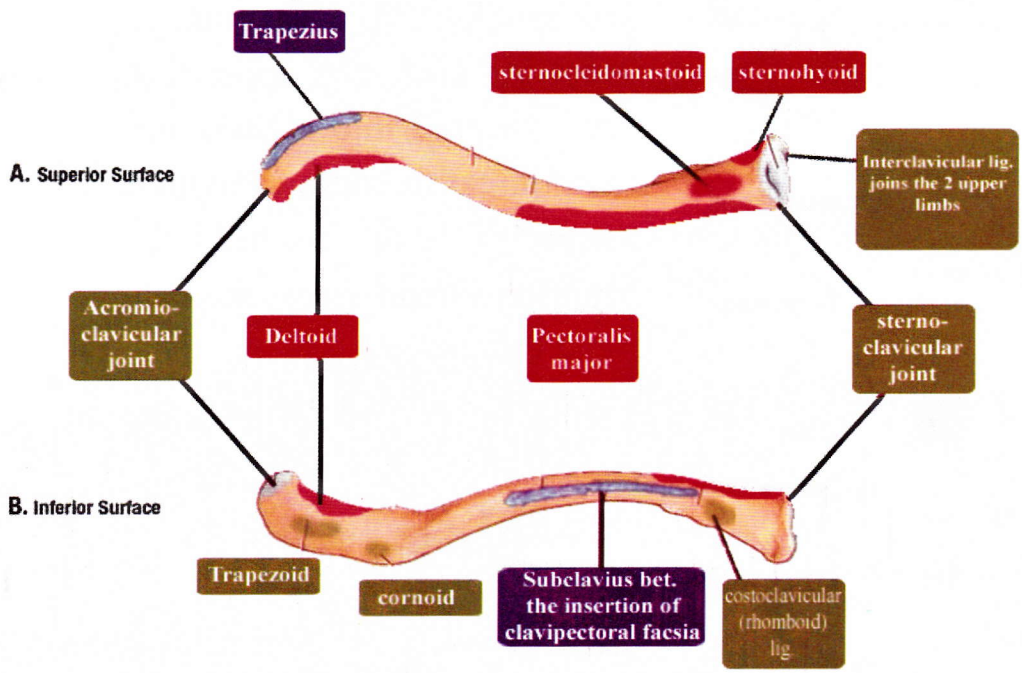
The Clavicle

Features:

- 2 ends: 1- Sternal end (bulky). 2- Acromial end (flattened).
- 2 surfaces: 1- Upper (smooth). 2- Lower (shows subclavius groove).

Surgical importance:

- The clavicle carries the weight of the upper limb & transmits it to the trunk through its articulation with the sternum (sterno-clavicular joint).
- It is one of the most commonly fractured bones in the body:
  - **Cause:** direct violence as falling on outstretched hand.
  - **Site:** the junction between the 2 curvatures.
  - **Effect:** shoulder drop; the lateral fragment is displaced downwards by the weight of the limb.

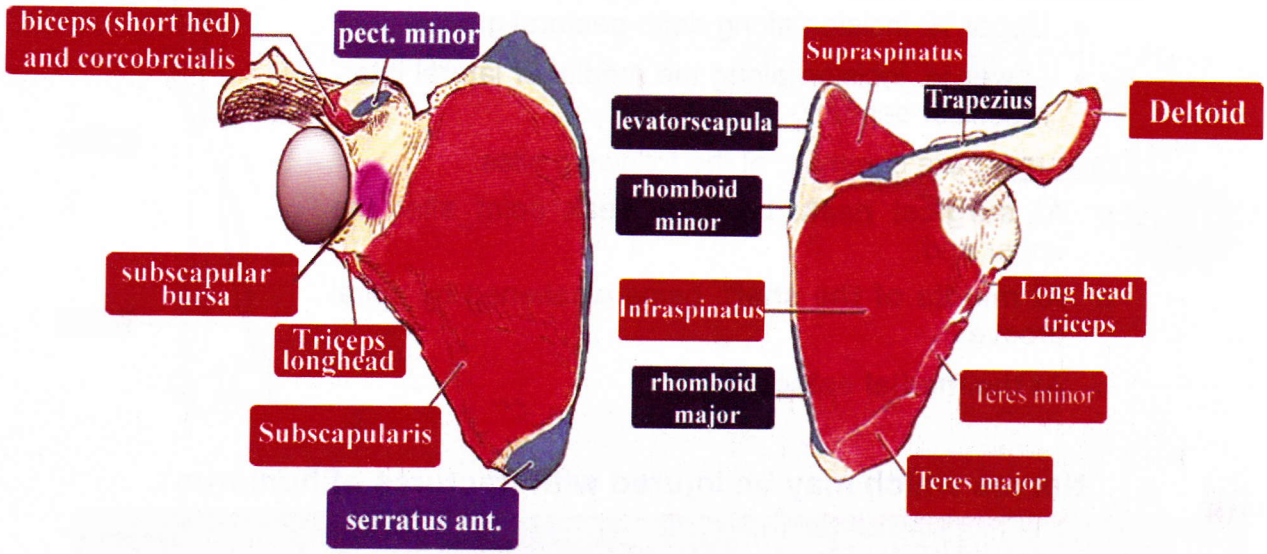


The Scapula

Features: a flat bone having:

1. **2 surfaces**: ventral (forming sub-scapular fossa) & dorsal (presenting the spine).
2. **3 borders:** upper, medial & lateral.
3. **3 angles:**
   - Superior (level of 2nd rib).
   - Inferior (level of 7th rib).
   - Lateral (glenoid cavity).
4. **3 fossae:** sub-scapular (ventrally), supra-spinous & infra-spinous (dorsally).
5. **3 processes:** spine, acromion and coracoid process.

Attachments:



The Humerus

Features:

Upper end: consists of:

- **Head**: articulates with the glenoid cavity.
- **2 necks**: anatomical neck & surgical neck.
- **2 tuberosities:** greater (carrying 3 muscles facets) &lesser (carrying 1 muscular facet).
- **Bicipital groove:** having medial lip, lateral lip & floor.

Shaft: has:

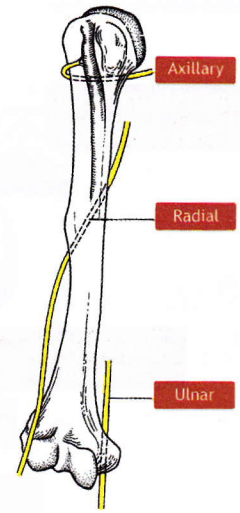
- **3 borders**: anterior, medial & lateral.
- **3surfaces**: antero-medial, antero-lateral & posterior surfaces.

Lower end: consists of:

- **Trochlea:** for articulation with ulna.
- **Capitulum:** for articulation with radius.
- **Medial epicondyle**: more prominent.
- **Lateral epicondyle**: less prominent.
- **3 fossae:** olecranon (posterior), radial & coronoid (anterior).

Surgical importance:

- **Surgical Exposure:**
  - Upper ⅓: incision along delto-pectoral groove.
  - Lower ⅔: incision along the medial or lateral inter-muscular septum.



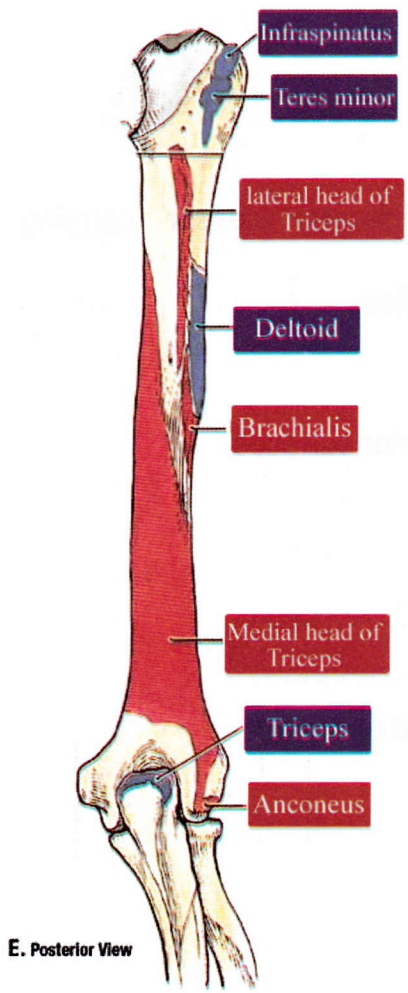
- **Fractures:** are common, at the following sites:

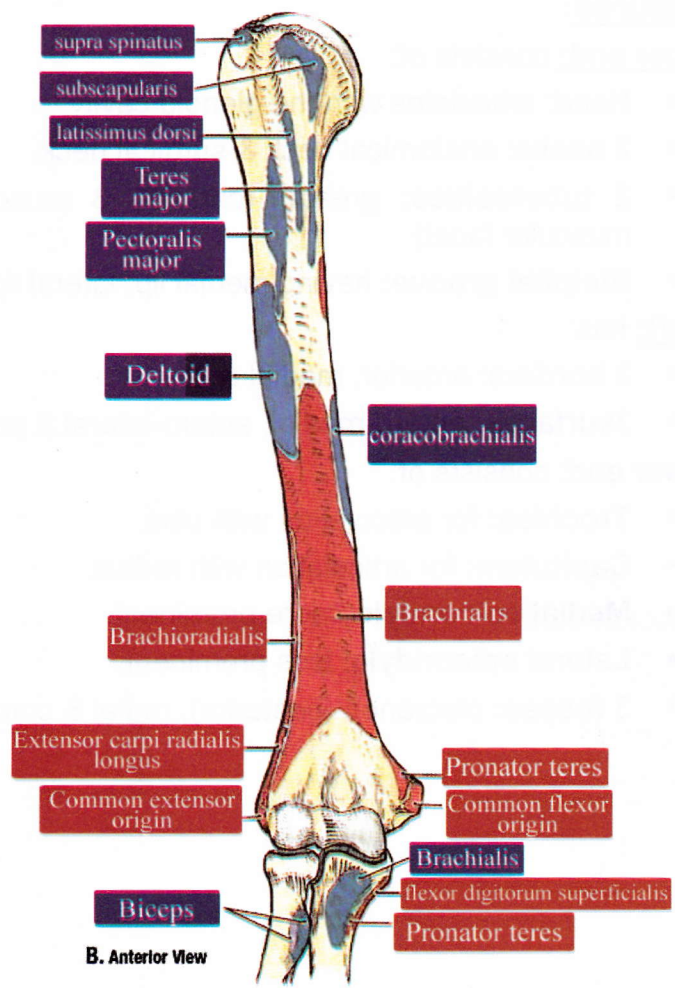
MCQ

  - **At surgical neck**: being a weak point after the upper end.
  - **At middle of the shaft**: being weakened by spiral groove.
  - **At the medial epicondyle.**

Nerves which may be injured with fractures of humerus

Site	The injured nerve	Effect of injury
Axillary n.	Around the surgical neck	**Flattened shoulder**
Radial n.	In spiral groove	**Drop-hand or wrist**
Ulnar n.	Behind medial epicondyle	**Claw hand**





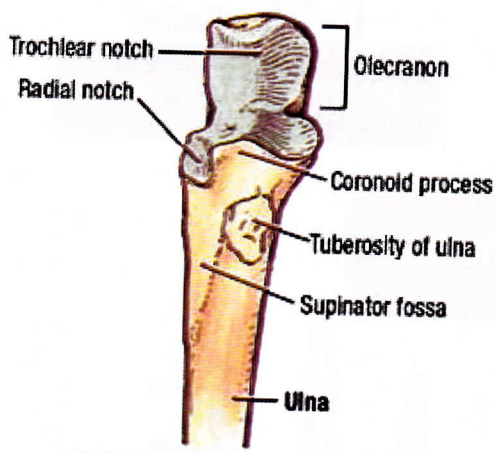
The Ulna

Features:

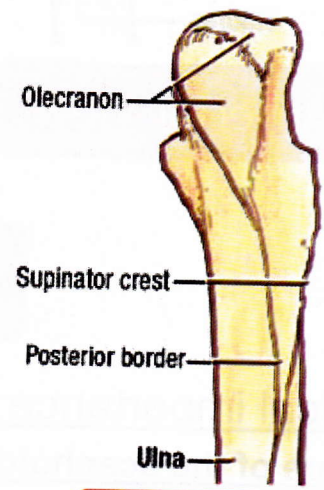
- **Upper end**: shows:-
  - 2 processes (olecranon &coronoid).
  - 2 notches (trochlear & radial).
  - 2 muscular impressions (ulnar tuberosity &supinator fossa).
- **Shaft:** has 3 surfaces (anterior, posterior & medial) separated by 3 borders.
- **Lower end:**- presents a small rounded head & a blunt styloid process.

Surgical importance:

- **Surgical exposure:** by an incision along its subcutaneous post. border
- The tip of the olecranon process forms an **equidistant Δ** with the 2 humeral epicondyles in the normal elbow & also in the supra-condylar fracture. In elbow dislocation, this Δ is no longer equidistant.



Anterior view



Posterior view

The Radius

Features:

- **Upper end**: consists of (head, neck & radial tuberosity)
- **Shaft**: has 3 surfaces (anterior, posterior & lateral) separated by 3 borders.
- **Lower end:** expanded & presents:

styloid process laterally, ulnar notch medially & articular surface (below).

Surgical importance:

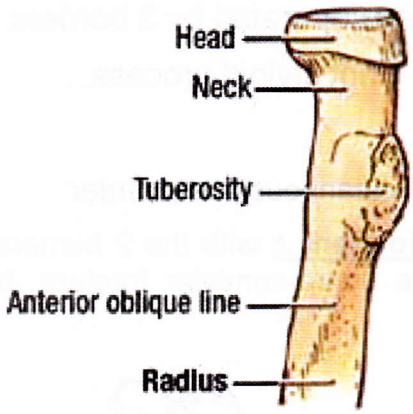
Surgical Exposure:

By an incision along the ant. border of brachioradialis.

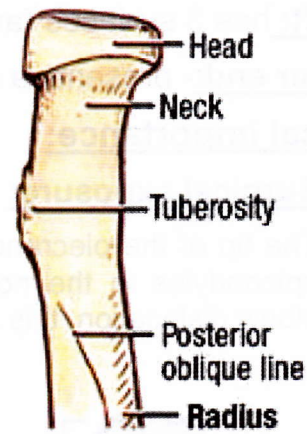
N.B. In Pronation & Supination

MCQ

- Ulna is fixed.
- Lower end of radius crosses in front of ulna
- Pronation by: pronator teres & pronator quadratus.
- Supination by : biceps (with elbow flexed) & supinator (with elbow extended)



Anterior view



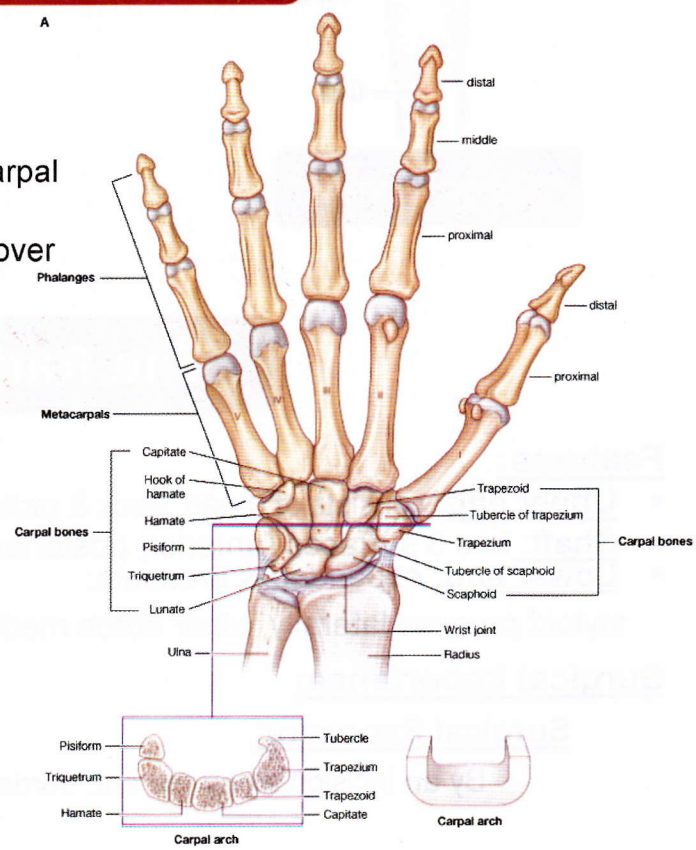
Posterior view

Carpal Bones

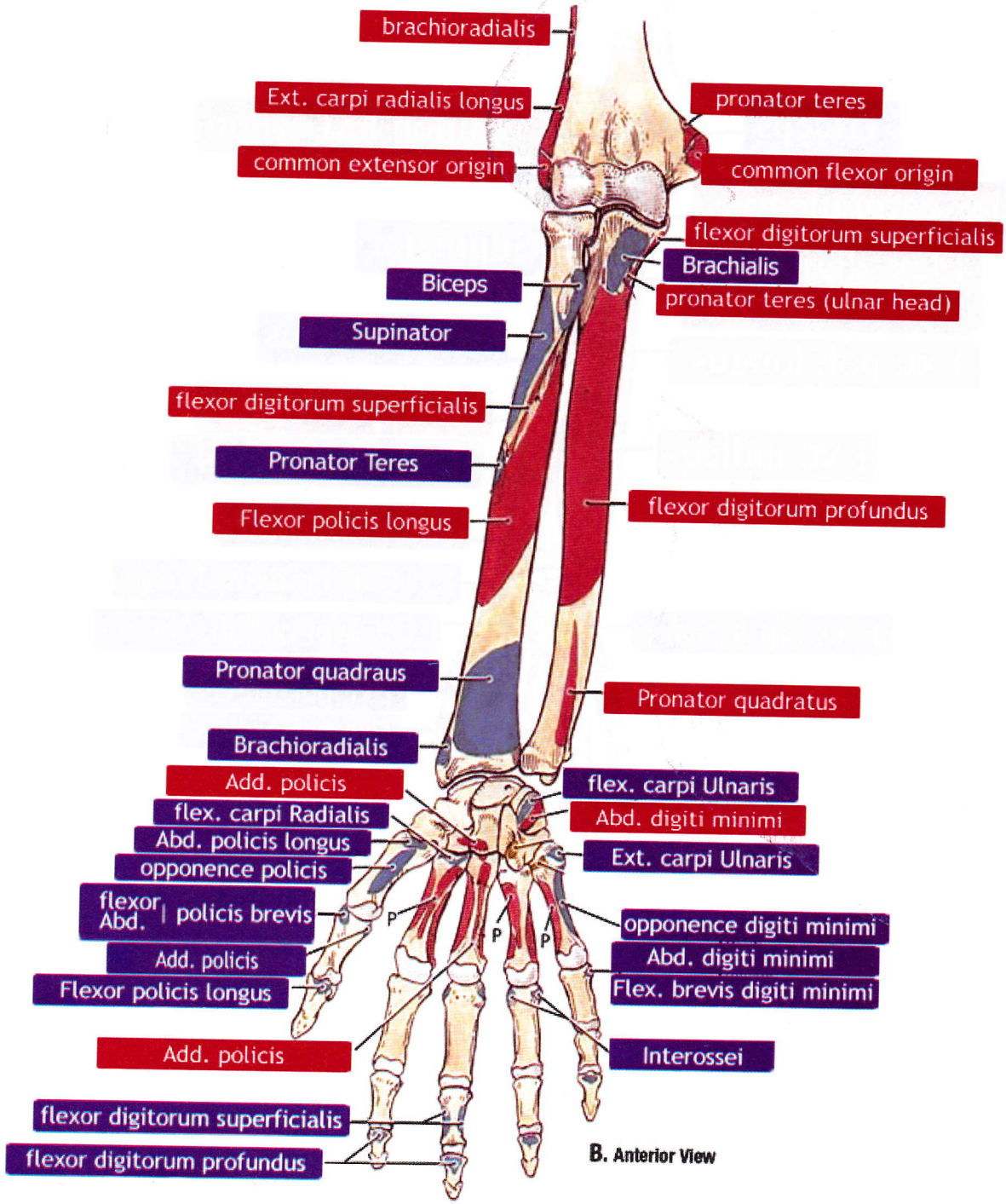
Surgical importance:

Fracture of the scaphoid

- It is the most frequently fractured carpal bone.
- Presents clinically with tenderness over the anatomical snuffbox.
- Has high incidence of avascular necrosis & non-union.

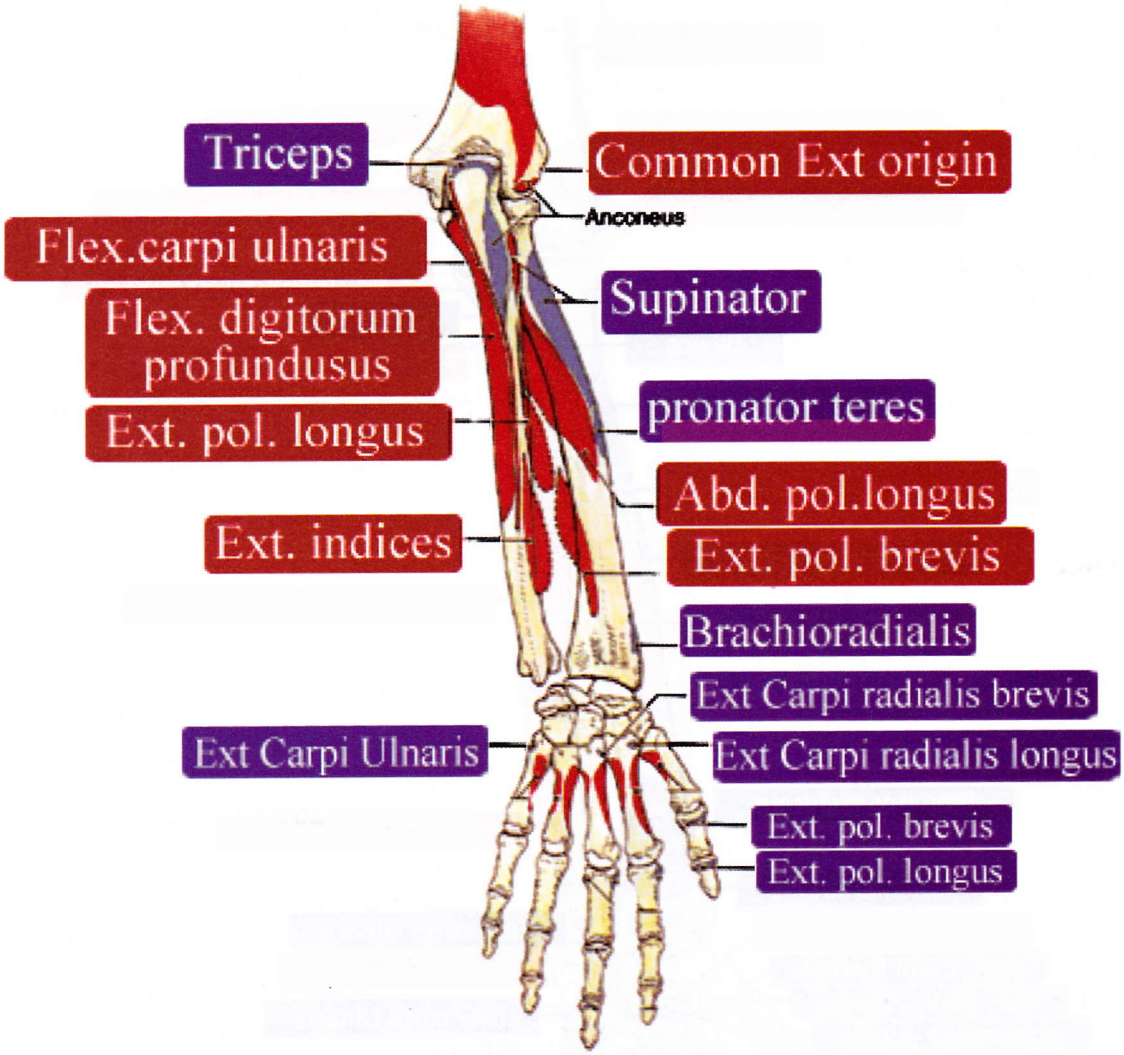


Attachments of forearm & hand (Anterior)



B. Anterior View

Attachments of forearm & hand (Posterior)



Joints of the Upper Limb

Sterno-clavicular & acromio-clavicular joints

Both are responsible for movements of the shoulder girdle.

Shoulder joint

- **Type:** Synovial (ball & socket).
- **Bones**: Head of the humerus & glenoid cavity of the scapula.
- **Stability of shoulder joint:** maintained by:
  - Coraco-acromial arch.
  - Rotator cuff muscles (supra-spinatus, infra-spinatus, sub-scapularis and teres minor).
- **Instability of shoulder joint:** due to:
  - Shallow glenoid cavity & large head of humerus.
  - Laxity of capsule.
  - Wide range of movement.

MCQ

- **Abduction at Shoulder Joint:**
  - **First 90°** → movement occurs at shoulder joint:
    - **From 0°- 30°** → supra-spinatus.
    - **From 30° - 90°** → middle fibers of deltoid.

MCQ

  - **From 90° – 180°** → no movement at shoulder joint (scapula is rotating by lower 5 digits of serratus anterior & upper & lower fibers of trapezius.

Elbow joint

- **Type**: Synovial (hinge).
- **Bones**: Lower end of humerus & upper end of radius & ulna

MCQ N.B: Student's elbow due to: inflammation of subcutaneous olecranon bursa

Superior & inferior radio-ulnar joints

- **Type**: Synovial (pivot).

Wrist joint

- **Type**: Synovial (ellipsoid).
- **Bones**: Lower end of radius & carpal bones (scaphoid, lunate & triquetrium).

Breast

DEVELOPMENT:

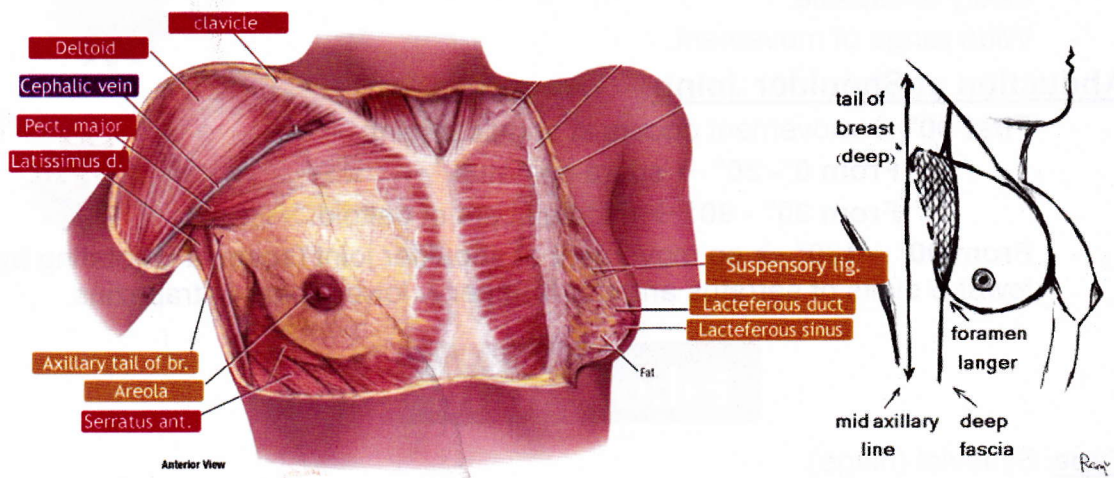
- It arises from the milk line, which extends from the axilla to the inguinal region (mid-inguinal point).
- The epithelium is ectoderm (parenchyma) while connective tissue is mesenchyme (stroma).

SITE & EXTENT:

- The breast is formed of fibro-fatty tissue, lies in front of the chest wall.
- It is considered as modified sebaceous gland, so it lies in **superficial fascia**.
- It extends from the 2nd to the 6th rib & from the sternum to mid axillary line.
- **The axillary tail of Spence:**

MCQ

  - Arises from supero-lateral quadrant of mammary gland.
  - Passes through a defect in the deep fascia known as foramen of Langer to the level of the third rib.
  - It lies close to the axillary vessels.



IT LIES OVER

The Pectoralis major (⅔): (see muscles of the shoulder region)

- **Origin:** sternocostal head, clavicular head.
- **Insertion:** lateral lip of bicipital groove.
- **Nerve Supply:** medial & lateral pectoral nerves (from medial & lateral cords of the brachial plexus respectively).
- **Action:** to press her hands against her waist.

The Serratus anterior (⅓):

- **Origin:** 8 digitations with the upper 8 intercostal muscles.
- **Insertion:** medial border of the scapula.
- **Nerve supply:** N. to serratus anterior from roots C5, 6, 7 (=Long thoracic n. = N. of Bell).
- **Action:** keeps the stability of scapula with the use of upper limb.

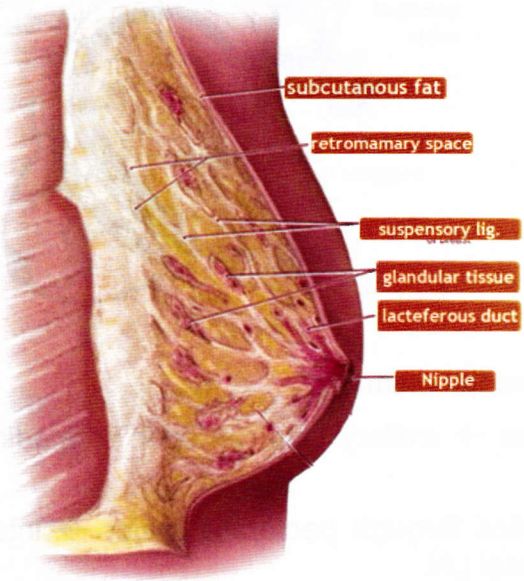
Others are the external oblique & rectus sheath.

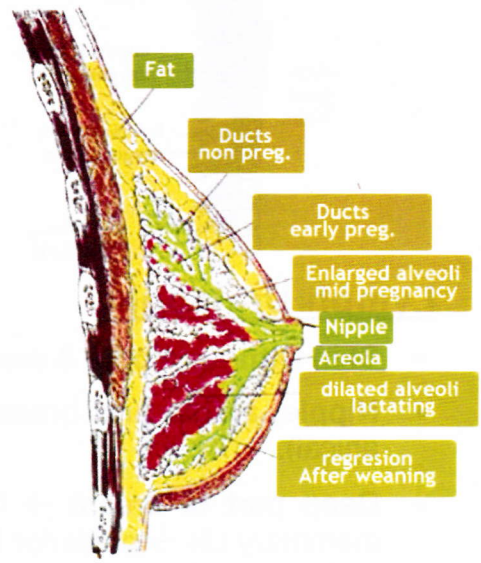
ARCHITECTURE OF THE GLAND:

- The breast is formed of acini that make up lobules & lobes of the gland which are radially-arranged.
- Each lobe is drained by a separate duct.
- All the collecting ducts (10 -15) open into the nipple.
- **Ligaments of Cooper:**

  The breast is anchored to the overlying skin & to the pectoral fascia by bands of CT called Ligaments of Copper.

Breast tissue is formed of glands + fibro-fatty CT where thickening in the fibrous tissue → Cooper ligament



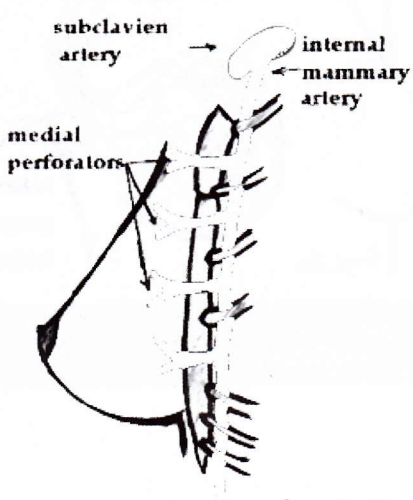


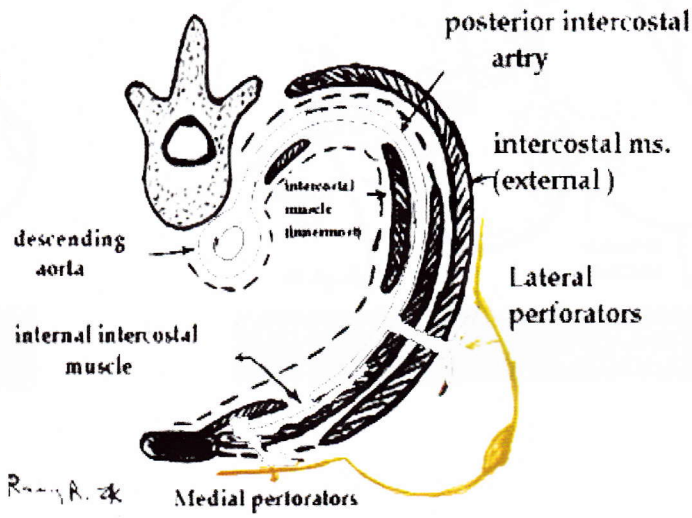
BLOOD SUPPLY OF THE BREAST:

Arterial Supply

MCQ

1. **The lateral thoracic artery**, from 2nd part of the axillary artery.
2. **The perforating cutaneous branches** of internal mammary artery to the 2nd, 3rd & 4th spaces (medial perforator).
3. **Lateral branches** of the 2nd, 3rd & 4th intercostal arteries (lateral perforators).

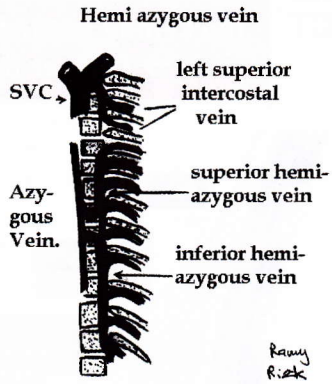


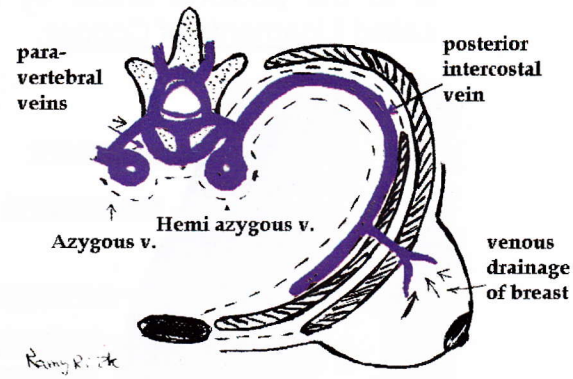


Venous Drainage

1. **Superficial Veins** cross the midline.
2. **Deep veins** accompany the int. mammary & intercostals arteries.
3. **Intercostal veins** drain into the azygous system on the Rt. side & hemiazygous on the Lt. Side, & vertebral veins, so cancer breast spreads to axial skeleton.

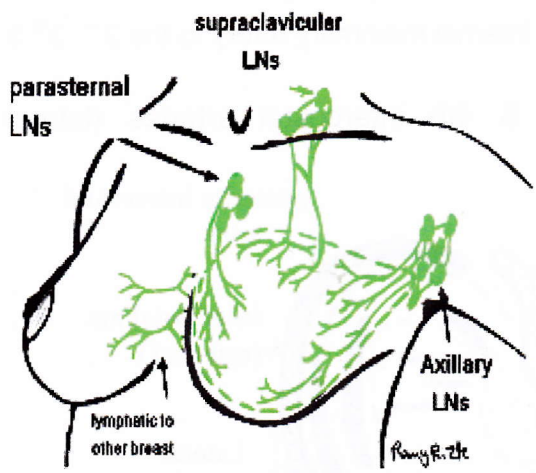
N.B. Phlebitis of the superficial veins is called Mondor's disease (superficial thrombophlebitis of the breast)



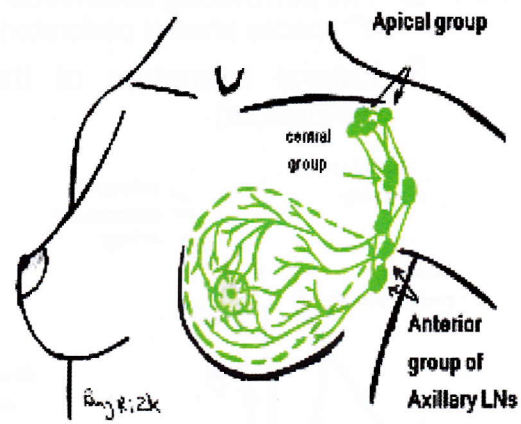


Lymph Drainage:

- **Skin without nipple & areola** → radial manner.
- **Nipple, areola and breast tissue** → axillary LNs (anterior → medial → apical).
- **Deep part of breast** → lymphatics through pectoralis major → internal mammary LN → posterior Intercostal LN.
- **Lower medial part** → lymphatics in rectus sheath & falciform ligament → metastasis in liver.

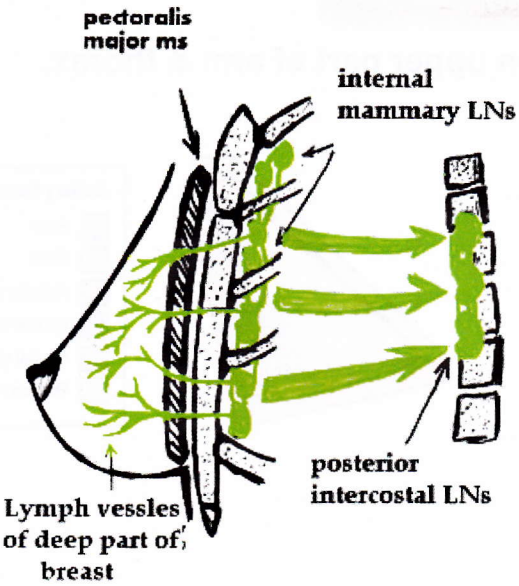


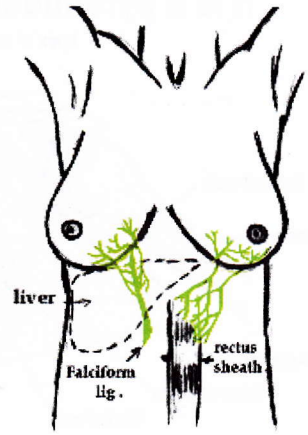
lymphatic drainage of skin of breast without nipple and areola (radial manner)



lymphatic drainage of nipple ,areola and breast tissue

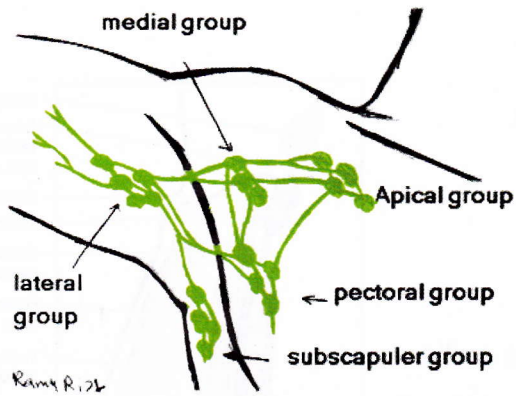
Lymphatic drainage of deep part of breast

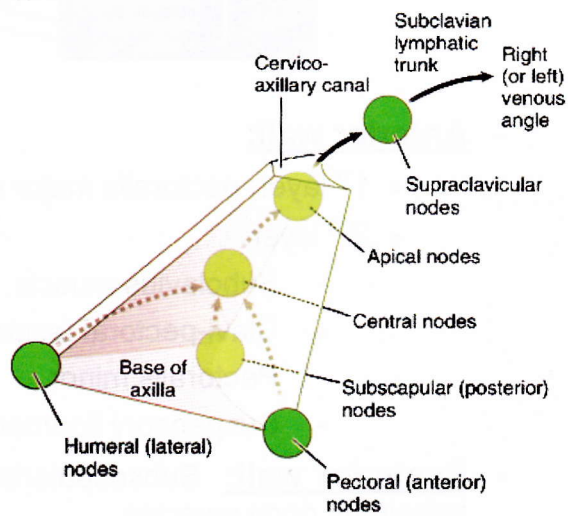




The axillary groups of lymph nodes

1. **Pectoral group (anterior)** → behind the pectoralis major.
2. **Humoral group (lateral)** → along the axillary vein.
3. **Sub-scapular group (posterior)** → over the subscapularis muscle.
4. **Central group (medial)** → over the floor of the axilla.
5. **Apical group (infra-clavicular)** → at the apex of the axilla.



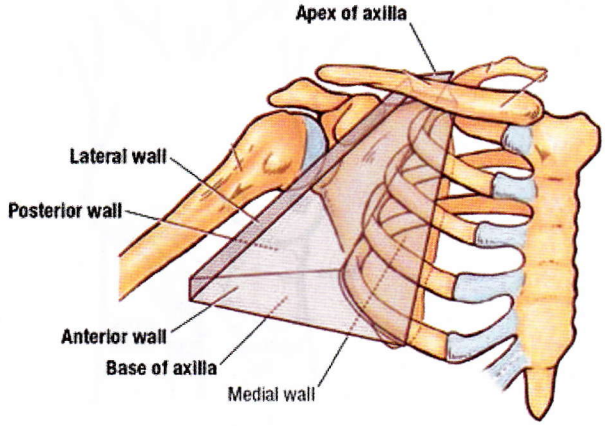


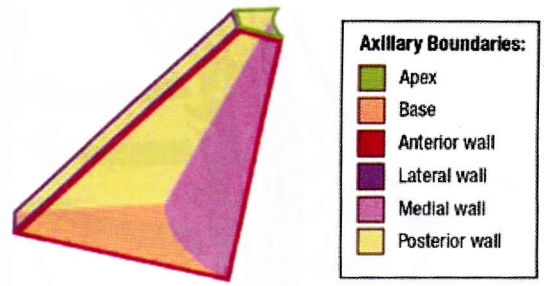
N.B: **The axillary LNs drain:** MCQ

- The upper limb.
- The mammary gland.
- Body wall above the level of umbilicus.

Axilla

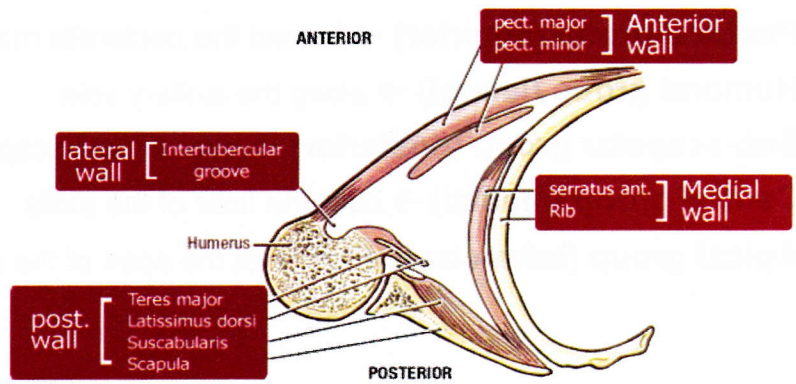
It is a pyramidal space between upper part of arm & thorax.



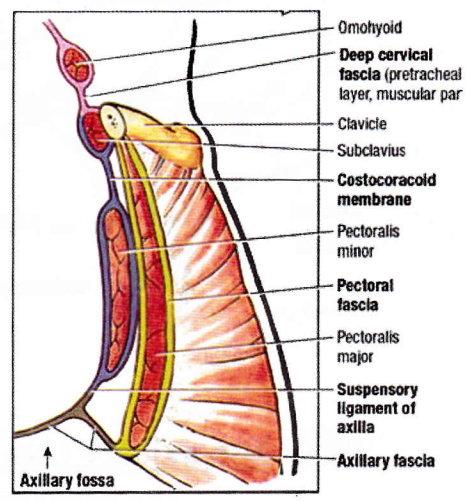


BOUNDARIES:

MCQ



- **Anterior wall:**
  - 1st layer: pectoralis major muscle.
  - 2nd layer:
    - Subclavius muscle.
    - Clavi-pectoral fascia.
    - Pectoralis minor.
    - Suspensory ligament of the axilla.



- **Posterior wall:** Subscapularis, teres major & latissimus dorsi muscles.
- **Medial wall:**
  Upper 4 ribs & serratus anterior muscle with long thoracic nerve running over it.
- **Lateral wall:**
  Formed by narrow strip of the inter-tubercular groove of the humerus, (with the origin of biceps & coracobrachialis muscles).

APEX: MCQ

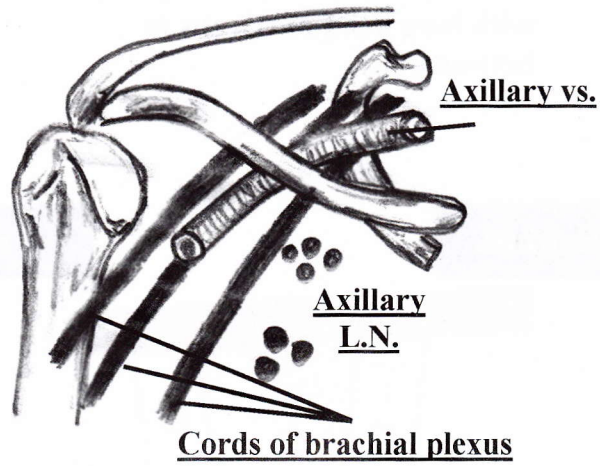
- Through which the neck (posterior triangle) is connected with the axilla (i.e.: the nerves & vessels pass through it).
- It bounded by:
  - **In front:** middle ⅓ of the clavicle.
  - **Medially**: outer border of the 1st rib.
  - **Behind:** upper border of the scapula.

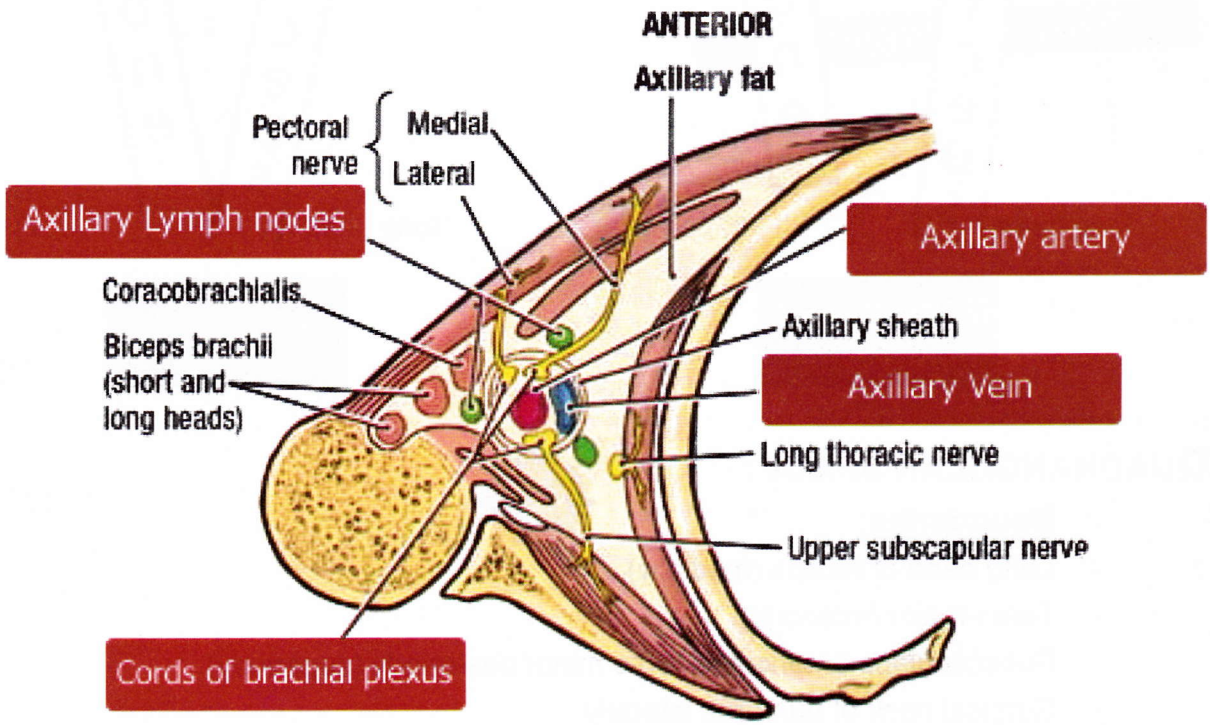
BASE: closed by the axillary fascia.

CONTENTS:

MCQ

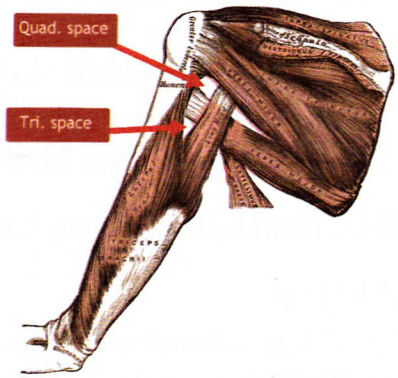
1. Cords of brachial plexus.
2. Axillary vessels (cephalic vein joins axillary vein in the axilla).
3. Several groups of LNs.



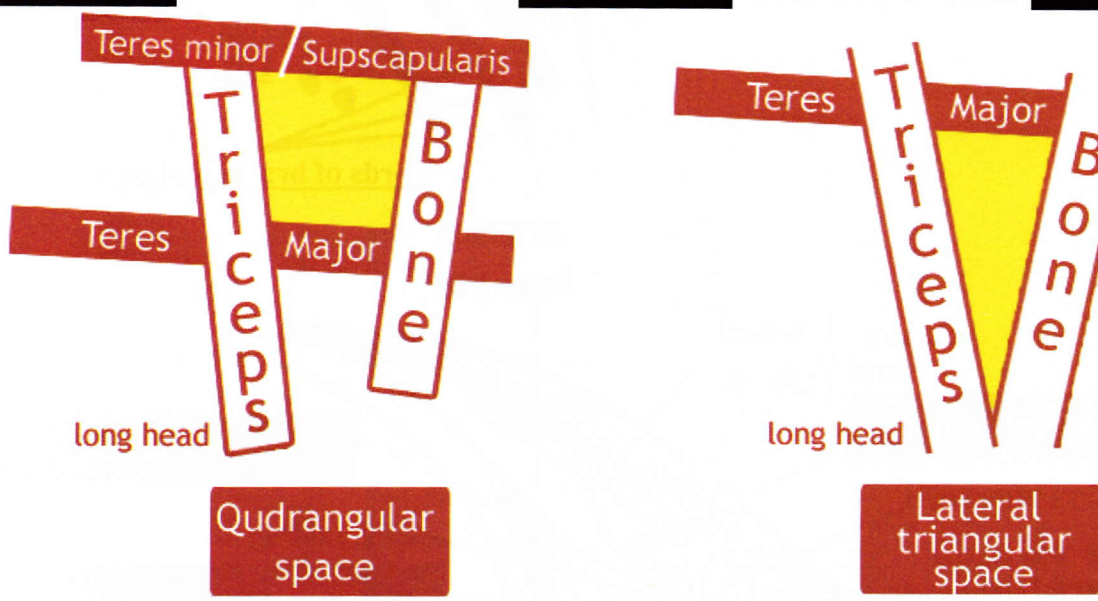


Quadrangular and Triangular spaces

- **These are muscular spaces, situated just below the lateral border of the scapula.**
- **The quadrangular space is lateral to the medial triangular space, with long head of triceps in between.**



Behind **Front** **Behind**



QUADRANGULAR SPACE:

MCQ

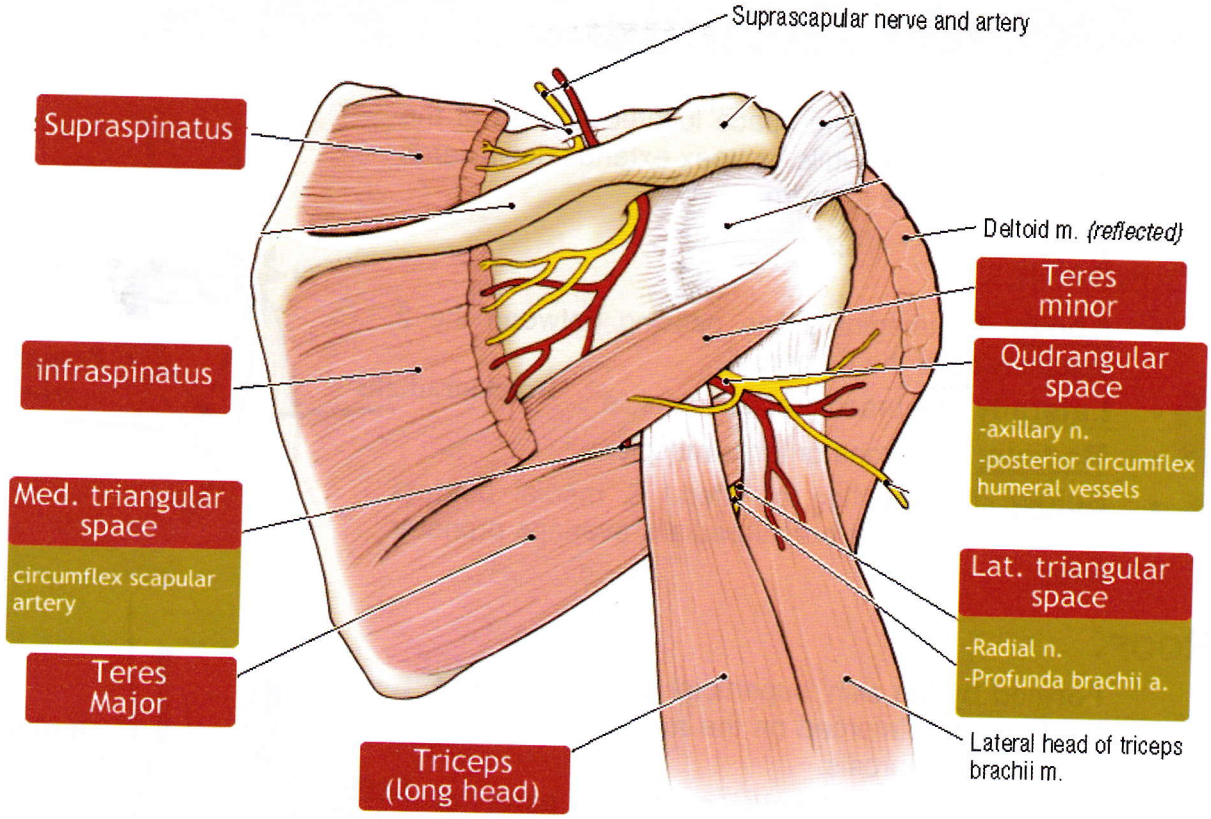
- **Boundaries:**
  - Long head of triceps (medially).
  - Teres major (inferiorly).
  - Subscapularis anteriorly & teres minor posteriorly (superiorly).
  - Surgical neck of humerus laterally.
- **Contents**: axillary nerve & posterior circumflex humeral vessels.

UPPER TRIANGULAR SPACE:

- **Contents**: circumflex scapular artery (from sub-scapular artery).

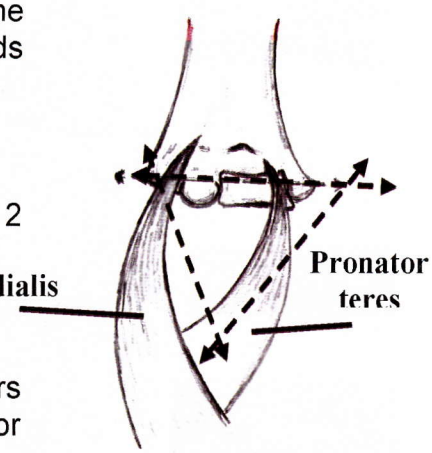
LOWER TRIANGULAR SPACE:

- **Contents**: radial nerve & profunda brachii artery.


Suprascapular nerve and artery
Supraspinatus
Deltoid m. (reflected)
Teres minor
infraspinatus
Qudrangular space
-axillary n.
-posterior circumflex humeral vessels
Med. triangular space
circumflex scapular artery
Lat. triangular space
-Radial n.
-Profunda brachii a.
Teres Major
Triceps (long head)
Lateral head of triceps brachii m.

The Cubital Fossa

The cubital fossa is a triangle space located in front of the elbow; its base lies above while its apex extends downwards for a short distance in the forearm.

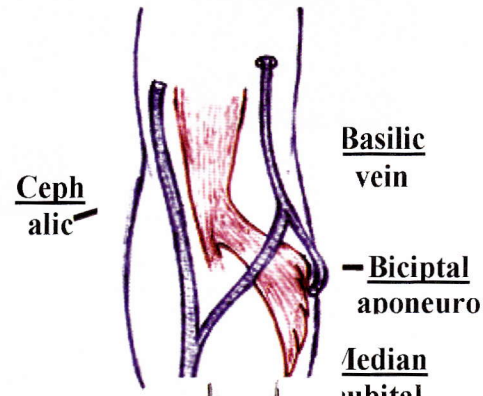


BOUNDARIES:

- **Above**: an imaginary line passing between the 2 epicondyles of the humerus.
- **Laterally**: the brachioradialis muscle. MCQ
- **Medially**: the pronator teres muscle.
- **Below:** the meeting of lateral & medial borders forms the apex but brachioradialis overlaps pronator teres.

ROOF:

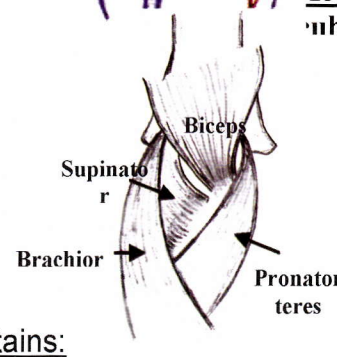
- **Formed by** the skin, superficial & deep fascia of the forearm reinforced on the medial side by the bicipital aponeurosis.
- **The superficial fascia contains** parts of cephalic vein, basilic vein, median cubital vein, anterior branch of medial cutaneous nerve of the forearm & lateral cutaneous branch of the forearm.
- The deep fascia is pierced by a connection between the median cubital vein & the deep veins.



FLOOR:

MCQ

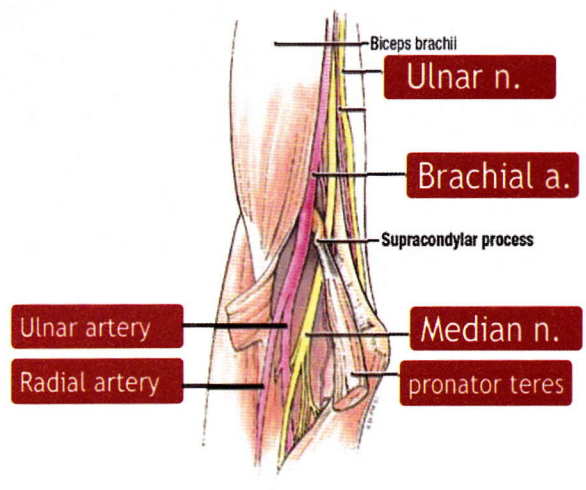
Formed by the lower part of the brachialis (on the medial side) & the anterior part of the supinator (on the lateral side).



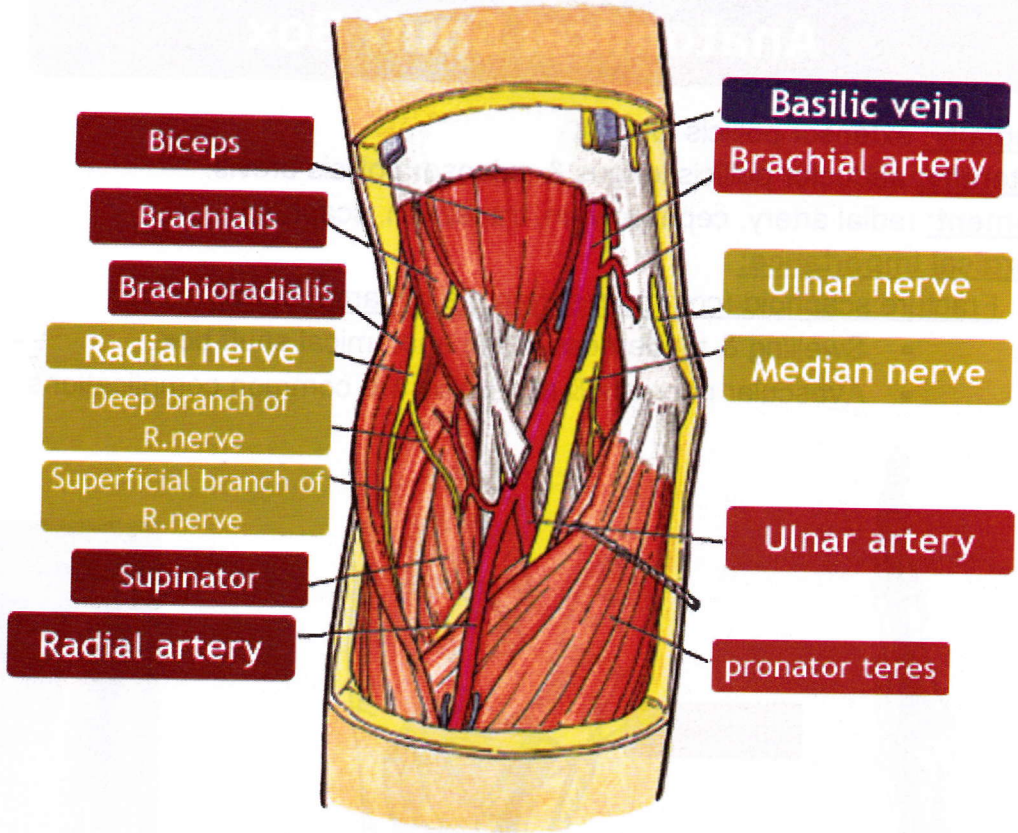
CONTENTS: From medial to lateral, the cubital fossa contains:

MCQ

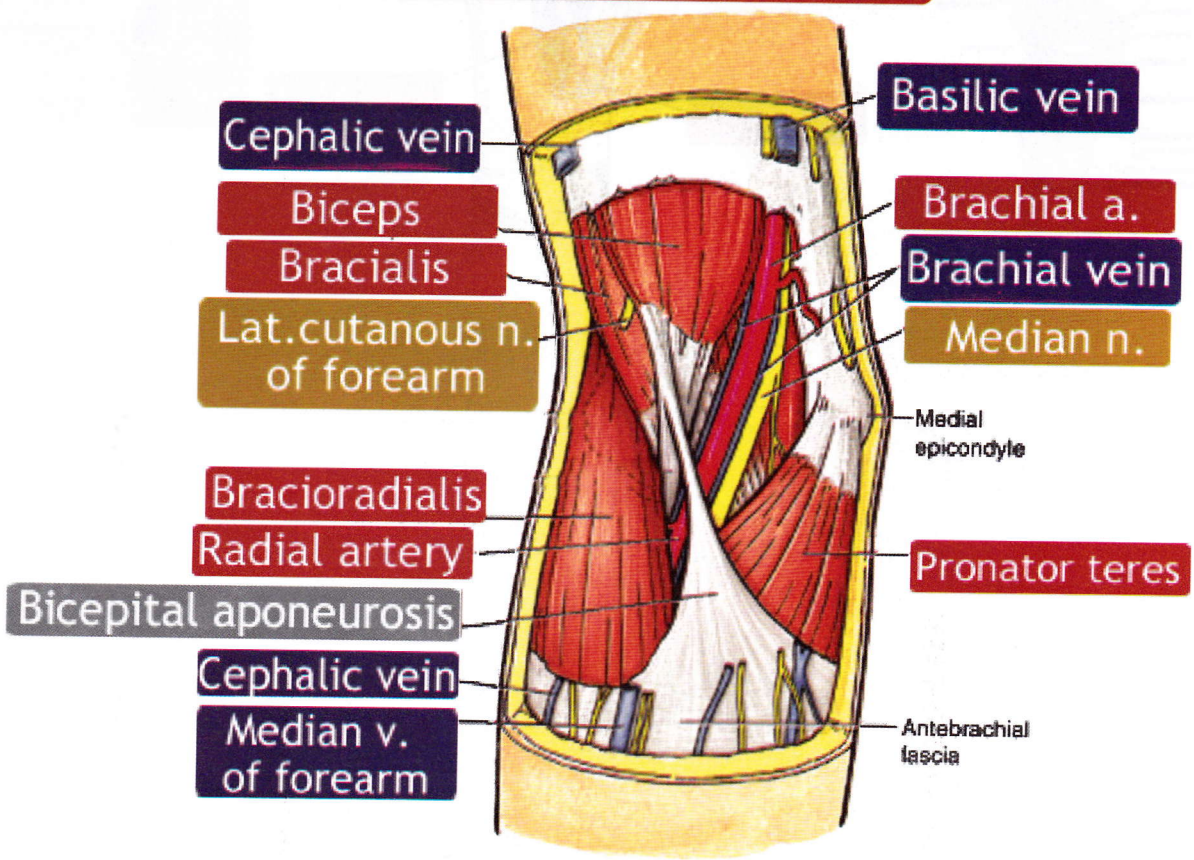
1. The median nerve.
2. The end of the brachial artery (palpated here medial to the tendon) & the origin of radial & ulnar arteries.
3. The biceps tendon.
4. The radial nerve & the beginning of its posterior inter-osseous branch (only seen when brachioradialis is retracted laterally).
5. The supra-trochlear LNs (in the upper & medial parts).



A. Anterior View



A) Superficial cubital fossa Rt.



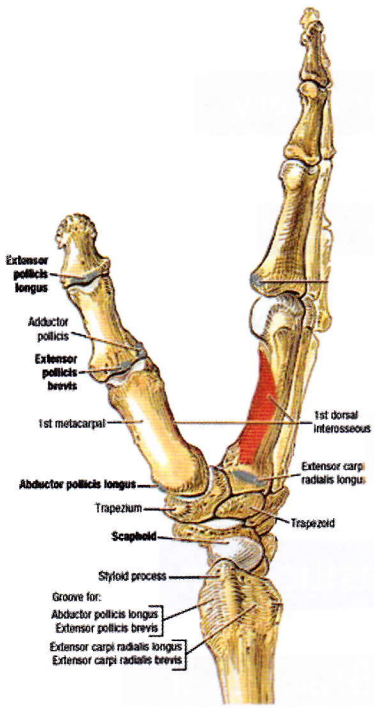
B) Deep cubital fossa Rt. side

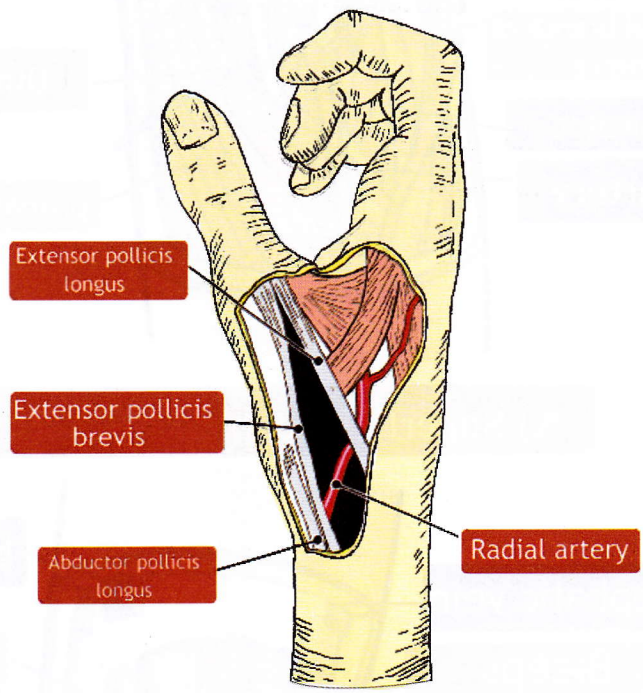
Anatomical Snuff Box

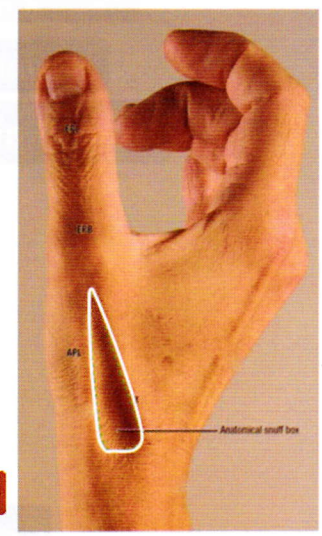
- **Medially:** extensor pollicis longus.
- **Laterally:** abductor pollicis longus & extensor pollicis brevis.
- **Content:** radial artery, cephalic vein, trapezium, scaphoid.
- **Surgical Importance:**

  Fracture scaphoid (commonest fracture of carpal bone):

  - Swelling & tenderness in the anatomical snuff box.
  - Avascular necrosis & non-union are common complications.





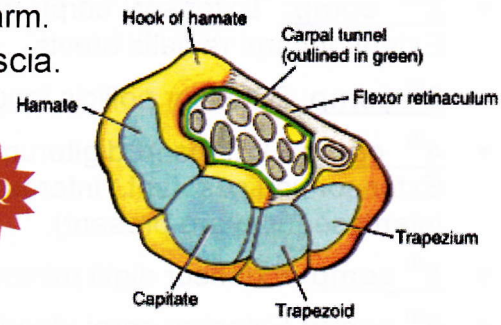


Flexor Retinaculum

SITE → Thick band stretches distal to wrist joint.

ATTACHMENTS:

- **Medially** → attached to pisiform bone & hook of hamate.
- **Laterally** → tubercle of scaphoid bone & crest of trapezium.
- **Superiorly** →to the deep fascia of the forearm.
- **Inferiorly** →central portion of palmar fascia.



SUPERFICIALLY (medial to lateral)

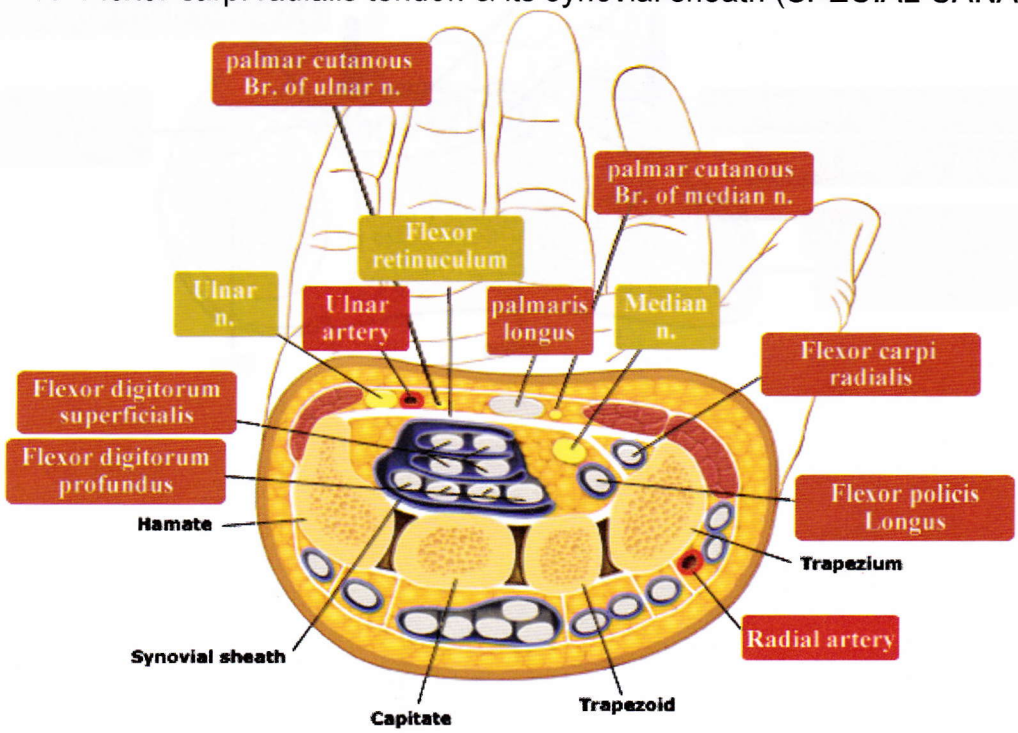
MCQ

1. Ulnar nerve.
2. Ulnar vessels.
3. Palmar cutaneous branch of ulnar nerve.
4. Tendon of palmaris longus muscle.
5. Palmar cutaneous branch of median nerve.

N.B: Radial artery does not pass superficial to flexor retinaculum

DEEP TO IT The carpal tunnel containing:

1. Flexor digitorum superficialis tendons.
2. Flexor digitorum profundus tendons.
3. Ulnar bursa enclosing flexor digitorum superficialis. & profundus tendons (tendons of superficialis are arranged in two starta).
4. Flexor pollicis longus tendon.
5. Radial bursa enclosing flexor pollicis longus tendon.
6. Median nerve.
7. Flexor carpi radialis tendon & its synovial sheath (SPECIAL CANAL).

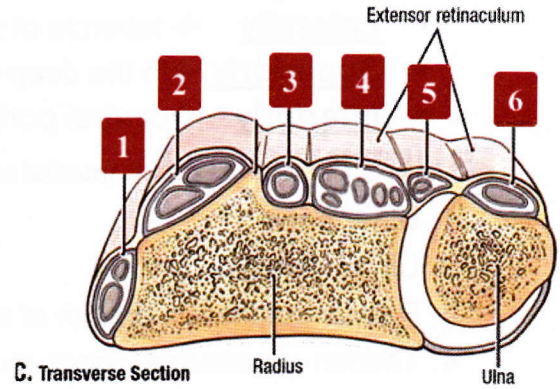


Extensor Retinaculum

Thickened part of deep fascia which covers the extensor tendons proximal to the wrist joint

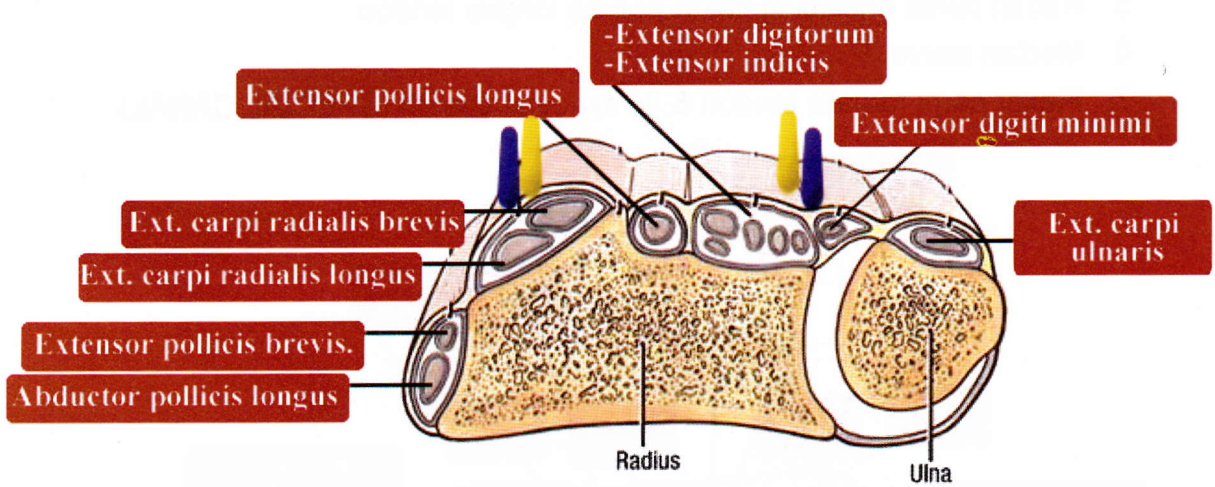
The space is divided by 5 septa into 6 compartments:

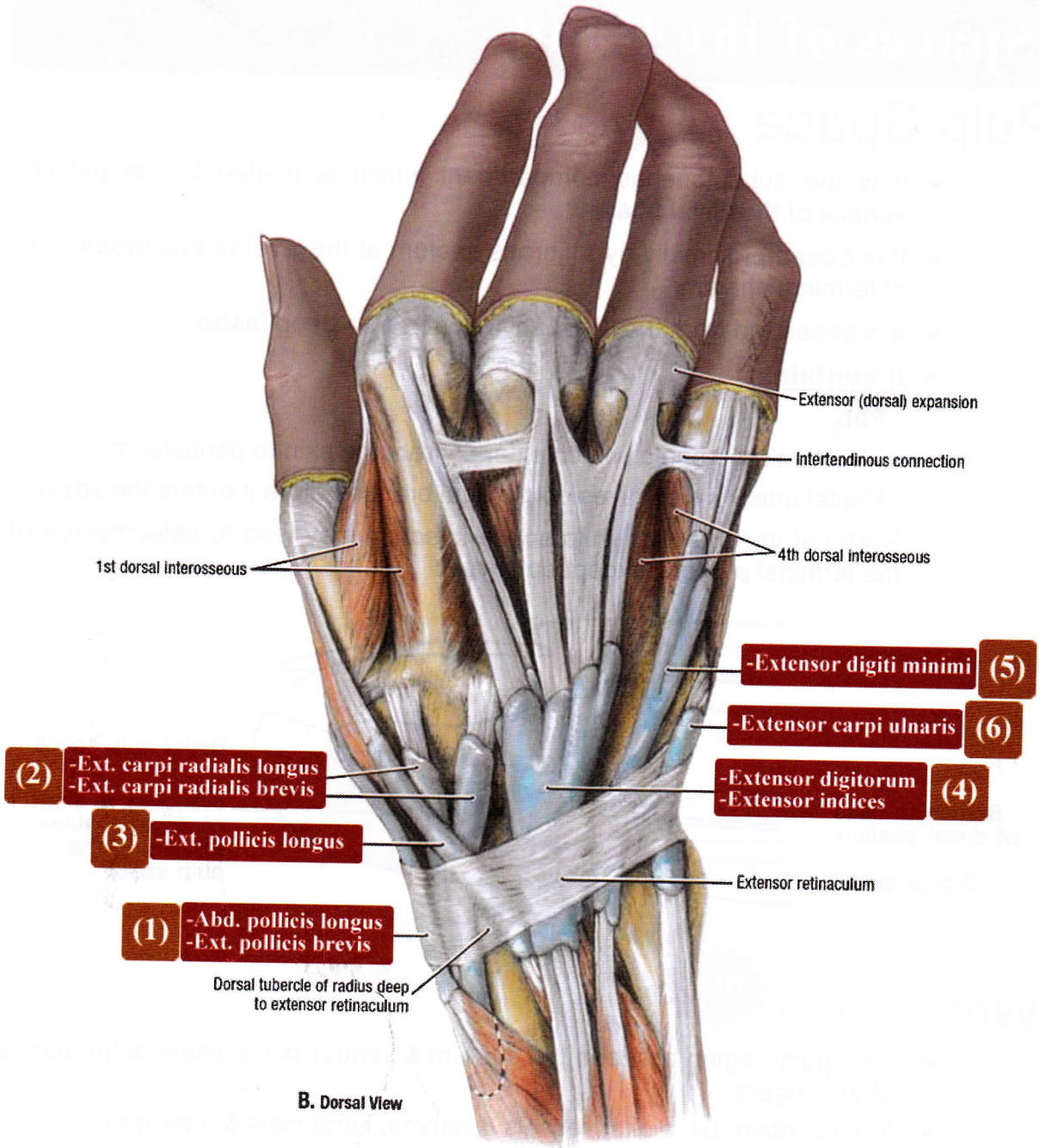
- **1st comp:** Abductor pollicis longus & Extensor pollicis brevis.
- **2nd comp:** Extensor carpi radialis longus & Extensor carpi radialis brevis
- **3rd comp:** Extensor pollicis longus.
- **4th comp**: Extensor digitorum (4 tendons) & Extensor indices (ant. interosseous A + post. interosseous n are present).
- **5th comp:** Extensor digiti minimi.
- **6th comp:** Extensor carpi ulnaris.



Structures superficial to the retinaculum

- 2 Veins: cephalic vein (lateral) & basilic vein (medial).
- 2 Nerves: Superficial branch of radial nerve (lateral) & dorsal branch of ulnar nerve (medial).





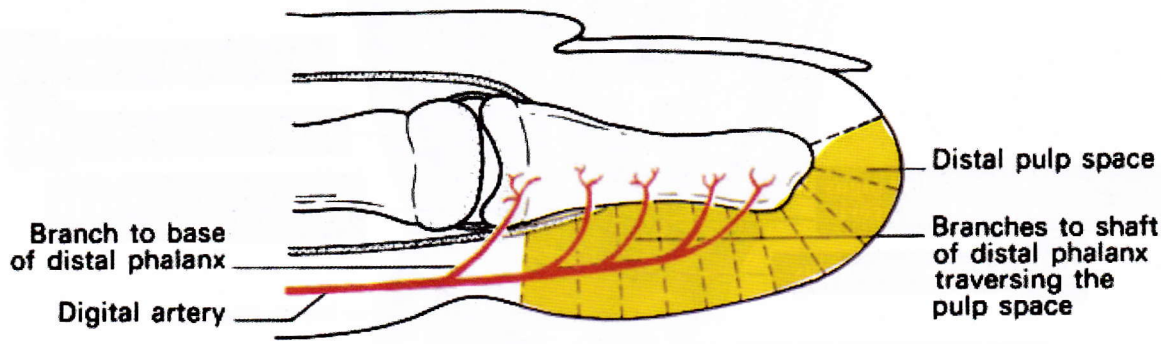
B. Dorsal View

Spaces of the Hand

Pulp Space MCQ

- It is the subcutaneous compartment which is related to the palmar surface of the distal phalanx.
- It is closed proximally by a fibrous septum at the level of epiphyseal line of terminal phalanx.
- It is separated from the distal volar space by a deep fascia.
- **It contains:**
  - Fat.
  - Fibrous tissue septa, which extends from the skin to periosteum.
  - Digital artery which gives epiphyseal branch before it enters the space.

  Surgical importance: Pulp space infection may lead to osteomyelitis of the terminal phalanx except epiphysis.



Web Space MCQ

- Triangular region between the dorsum & ventral skin present at the bases of the fingers.
- They contain: fat, digital vessels & nerves, lumbricals & interossei.
- **They communicate with mid-palmar & thenar spaces.**

Thenar space MCQ

- **Anterior →** thenar muscle, radial bursa, and flexor pollicis longus.
- **Posterior →** adductor pollicis & 2nd & 3rd metacarpals.
- **Medial →** deep mid palmar space (separated from it by a fibrous septum extending from palmar aponeurosis to 3rd metacarpal bone.
- **Distal →** extends to the web of the thumb.

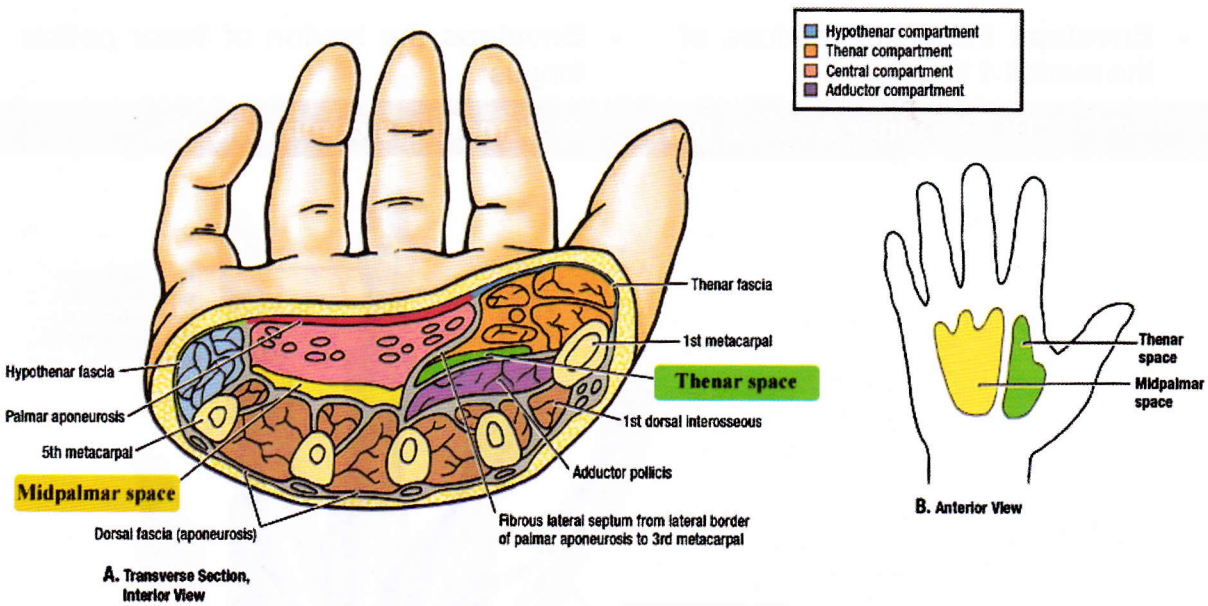
Superficial mid palmar space MCQ

- **Anterior →** middle part of palmar aponeurosis.
- **Posterior →** flexor tendons.

Deep mid palmar

MCQ

- **Anterior→** flexor tendon of the medial 3 fingers & ulnar bursa.
- **Posterior →** fascia covering the interossei & 3rd, 4th & 5th metacarpals.
- **Lateral →** fibrous band from palmar aponeurosis to 3rd metacarpal.
- **Distally →** 3 lumbrical canals to the medial 3 webs.
- **Medially →** separated from hypothenar muscles by medial palmar septum.



NB: Dupuytren's contracture:

MCQ

- It is a contracture of palmar aponeurosis.
- It affects its medial part.
- It leads to flexion of MP joint & sometimes proximal IP joint (DIP joint is not affected).
- It is seen in patients with liver cirrhosis.

Synovial sheath

- Synovial sheath of the middle 3 fingers

- Each finger of these has a separate synovial sheath.
- **Proximal end:**
  - At the level of metacarpo-phalangeal Joint.
  - Dilated Cul-de sac.

MCQ

- **Distal end** → at base of distal phalanges.
- They **enclose** the flexor tendons.

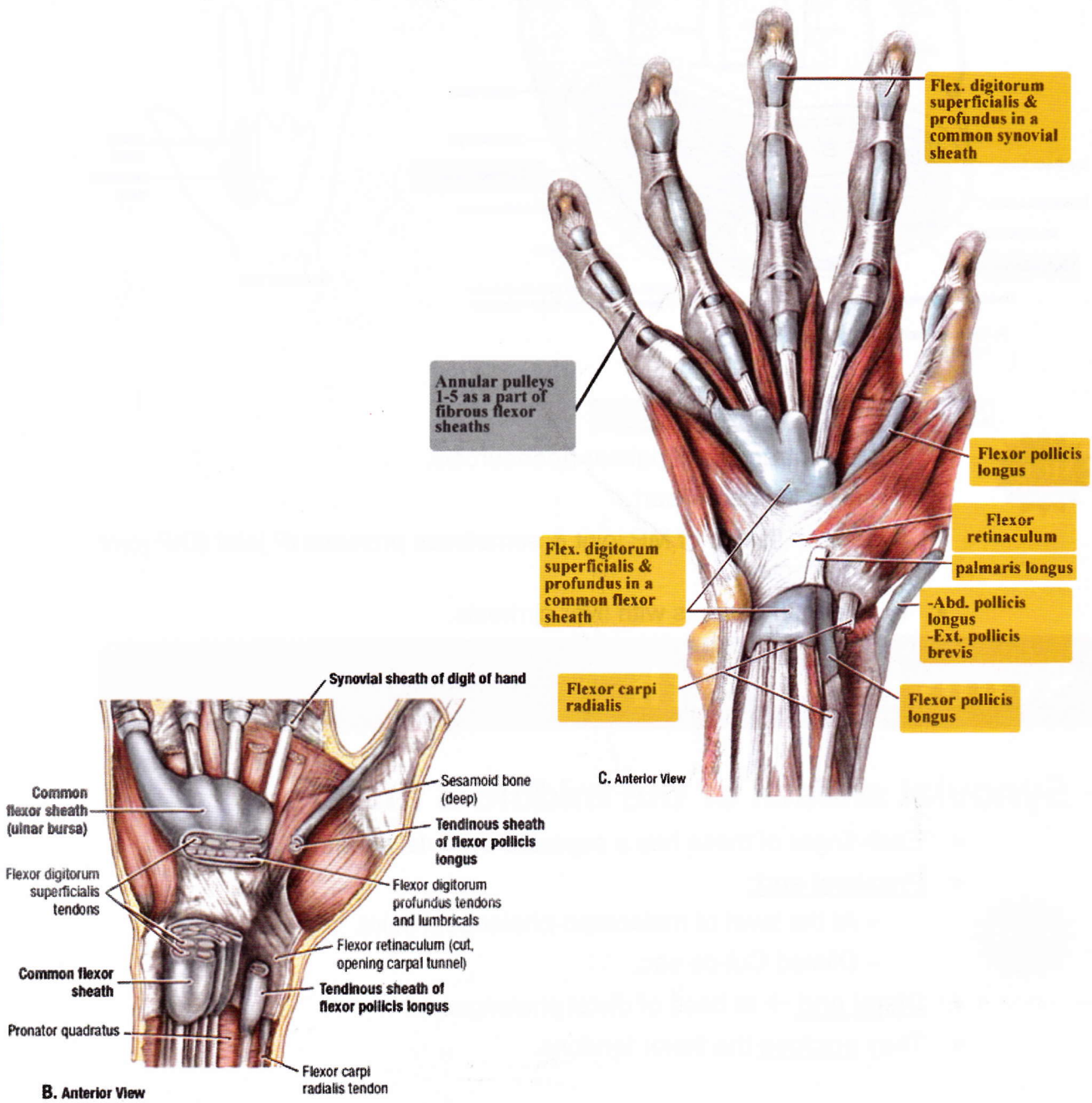
- Synovial sheath of the thumb &little fingers

MCQ

- Proximally they continue with radial & ulnar bursae, respectively.

Ulnar bursa	Radial bursa
- Larger	- Smaller
- **Distally** connected with synovial sheath of little finger	- **Distally** connected with synovial sheath of the thumb
- **Proximally** → runs below the flexor retinaculum → extends 1" in the forearm	
- **Envelops** the flexor tendons of the medial 4 fingers	- **Envelops** the tendon of flexor pollicis longus

N.B: The ulnar & radial bursa may sometimes communicate.



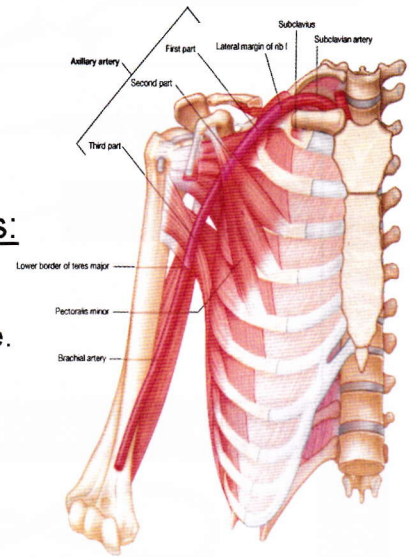
Blood vessels of upper limb

AXILLARY ARTERY

MCQ

BEGINS: at the outer border of 1st rib as a continuation of subclavian artery.

ENDS: at the **lower border of the teres major** muscle as brachial artery.



Pectoralis minor divides axillary artery into 3 parts:

A- 1st Part:

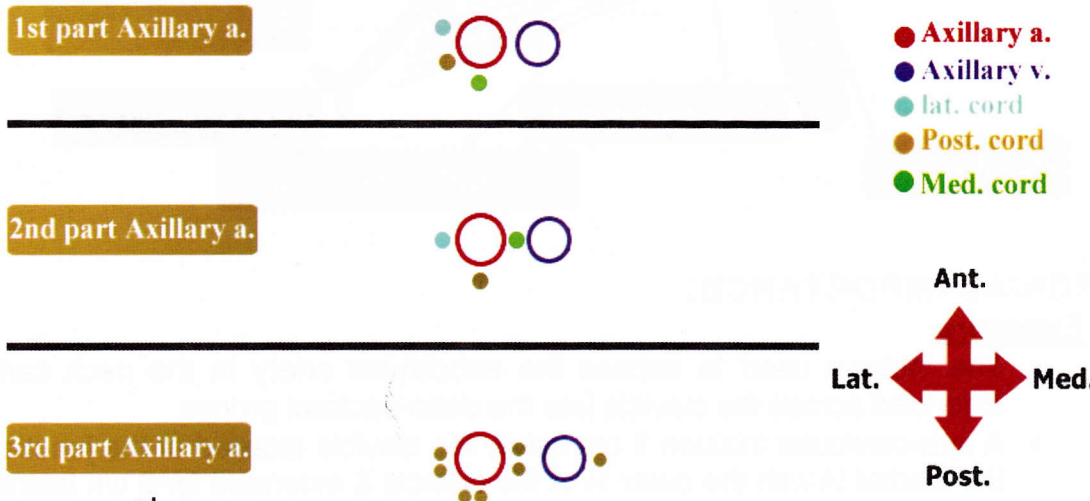
- Lies above the pectoralis minor muscle.
- **Relation**: (see diagram).
- **Branches**: superior thoracic artery.

B- 2nd Part:

- Lies behind pectoralis minor.
- **Relation**: (see diagram).
- **Branches**:
  1- Thoraco-acromial artery (pierce clavi-pectoral fascia).
  - ➢ It gives:- acromial, pectoral, clavicular & deltoid branches

MCQ

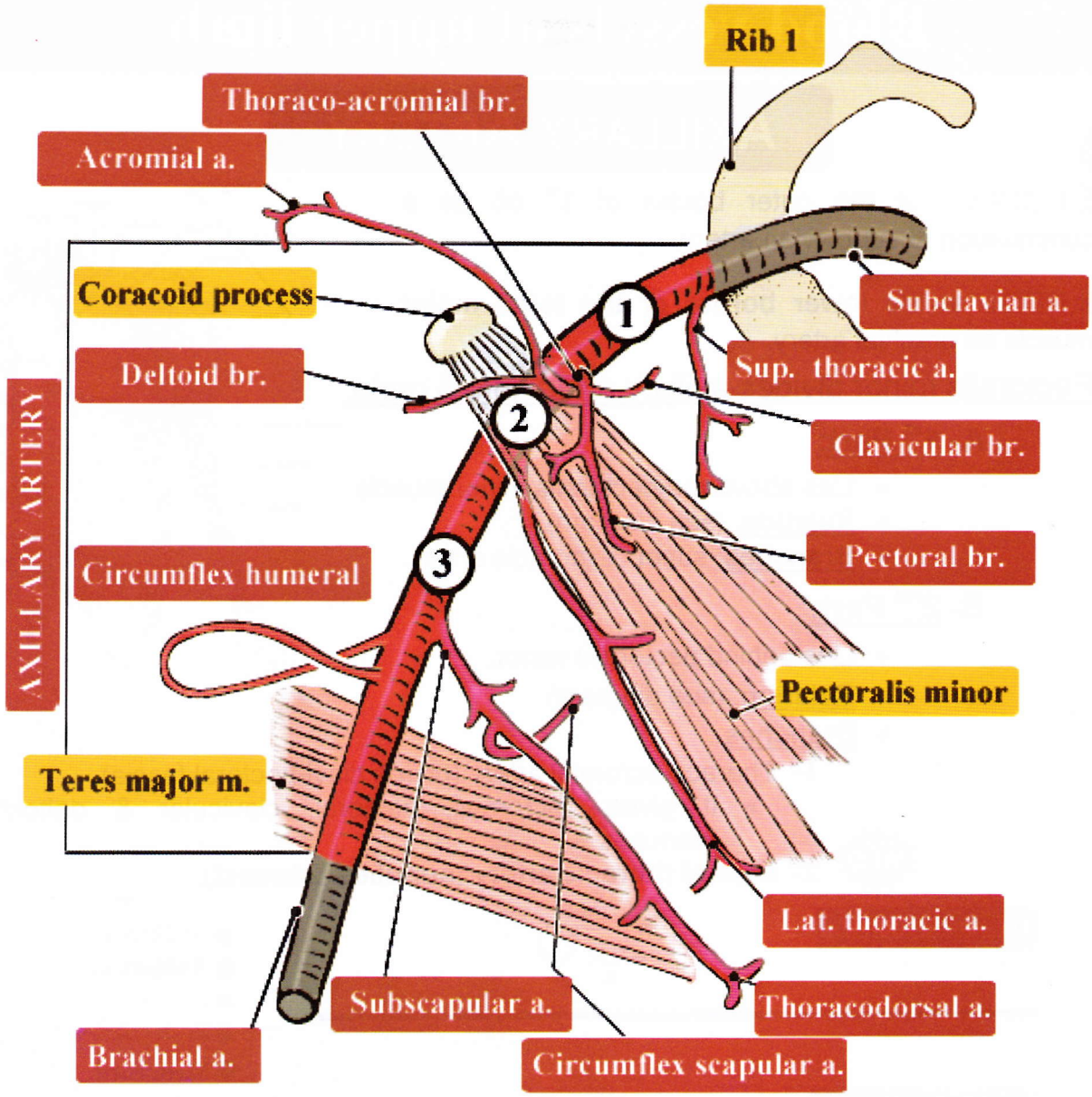
2- Lateral thoracic artery (supplies ♀ breast).



C- 3rd Part:

MCQ

- Lies below pectoralis minor.
- Lies medial to the short head of biceps & coracobrachialis.
- **Relation**: (see diagram)
- **Branches:**
  i. Sub-scapular: give circumflex scapular (anastomosis around scapula).
  ii. Posterior circumflex humoral: around the surgical neck.
  iii. Anterior circumflex humeral: around surgical neck and gives branches to the shoulder joint.



SURGICAL IMPORTANCE:

Exposure:

- The incision used to expose the subclavian artery in the neck can be extended across the clavicle into the delto-pectoral groove.
- A sub-clavicular incision 1 cm below the clavicle (started at the junction of the medial ¼ with the outer ¾ of the clavicle & extended for 6 cm laterally).

Brachial Artery

BEGINS: At the lower border of teres major.

ENDS: in the cubital fossa opposite the neck of radius by dividing into radial & ulnar arteries.

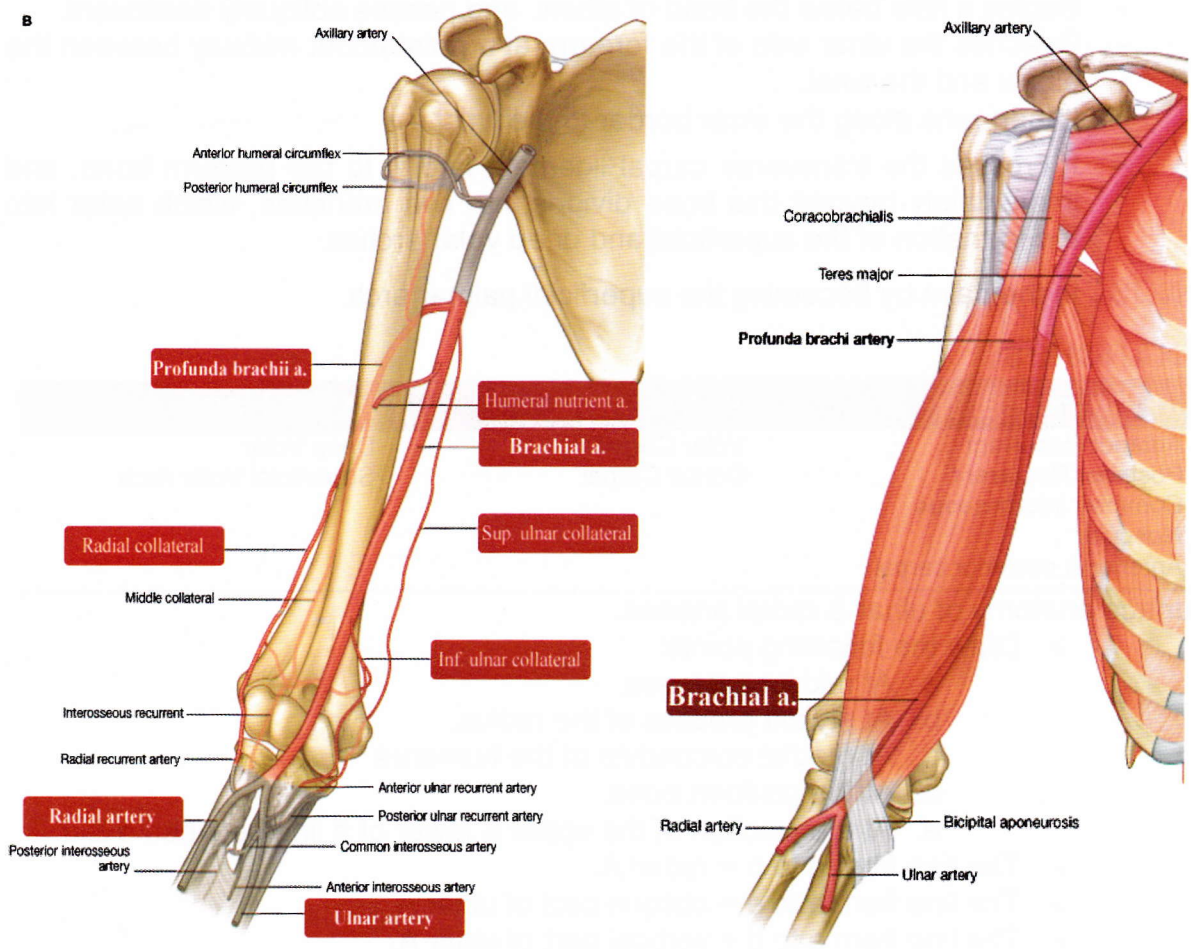
RELATIONS:

- Lies on anterior aspect of Triceps, coracobrachialis & brachialis muscles.
- Lies medial to biceps.
- In the cubital fossa, it is crossed by the median cubital vein.
- It is crossed by the median nerve.

BRANCHES:

- Profunda brachii.
  - ➢ It gives:
    - Ascending branch → shares in the anastomosis around the surgucal neck of humerus.
    - 2 descending branches →share in anastomosis around the elbow.
- Nutrient artery to humerus.
- Superior & inferior ulnar collateral arteries.

N.B: It can be palpated over most of its course.



PROFUNDA BRACHII ARTERY:

- A large vessel that arises from the medial and posterior part of the brachial artery, **just below the lower border of the teres major.**
- **It enters the spiral groove** together with the **radial nerve**, where it gives off the following branches:
    a. **Ascending branch:** ascends on the back of the humerus to anastomose with the post circumflex humeral artery.
    b. **2 descending branches** (anterior & posterior) that descend with the radial nerve towards the lateral epicondyle.

SURFACE ANATOMY OF AXILLARY & BRACHIAL ARTERIES:

- The arm should be abducted & the forearm should be supinated.
- Draw 3 points:
    a. At the midclavicular point.
    b. At the level of posterior fold of axilla.
    c. At midpoint of the cubital fossa.
- A line from a to b = Axillaray A.
- A line from b to c = Brachial A.

Ulnar Artery

BEGINS: in the cubital fossa as the larger of the 2 terminal branches of the brachial artery.

COURSE: **in the forearm:**

- Begins a little below the bend of elbow, and passes obliquely downward.
- Reaches the ulnar side of the forearm at a point about midway between the elbow and the wrist.
- It then runs along the ulnar border to the wrist.
- It crosses the transverse carpal ligament lateral to the pisiform bone, and immediately beyond this bone divides into two branches, which enter into the formation of the superficial and deep volar arches.

ENDS: in the palm by becoming the superficial palmar arch.

BRANCHES:

In the Forearm	At the Wrist	In the Hand
Anterior Recurrent	Volar Carpal	Deep Volar
Posterior Recurrent	Dorsal Carpal	Superficial Volar Arch
Common Interosseous		
Muscular		
Anterior & posterior carpal		

Surface anatomy of ulnar & radial arteries:

- Draw the following points:
    a. At midcubital fossa.
    b. At styloid process of the radius.
    c. At medial epicondyle of the humerus.
    d. At the pisiform bone.
    e. At the junction of the upper & lower of a line between c & d.
- The line from a to b = radial A.
- The line from a to e = oblique part of ulnar A.
- The line from e to d = vertical part of ulnar A.

Radial Artery

BEGINS: in the cubital fossa as the smaller of the 2 terminal branches of the brachial artery. Its origin lies at the level of the neck of the radius.

COURSE:

In the forearm:

- The artery leaves the cubital fossa at its apex, under cover of the brachioradialis muscle.
- It descends along the lateral side of forearm down to the wrist.
- It then winds backward, around the lateral side of the wrist.

In the dorsum of the hand:

- It passes in the floor of anatomical snuff -box.
- It passes forward between the two heads of the first Interosseous dorsalis, to reach the palm of the hand.

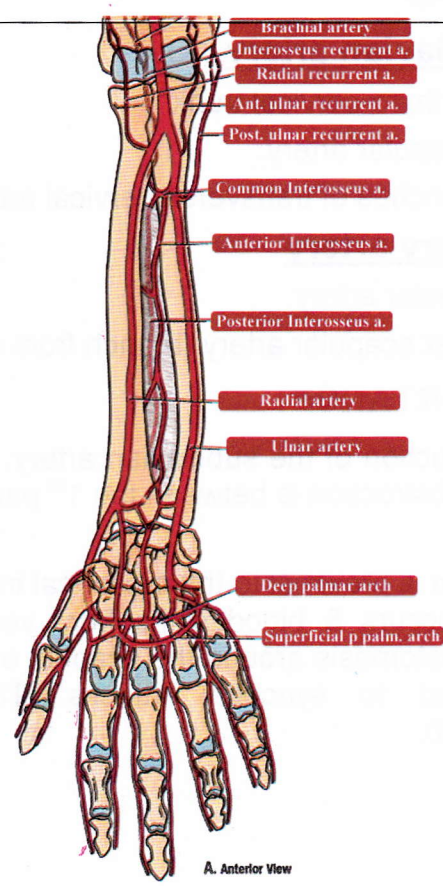
In the palm of hand:

It passes between the two heads of adductor pollicis.

ENDS: in the palm by becoming the deep palmar arch.

BRANCHES:

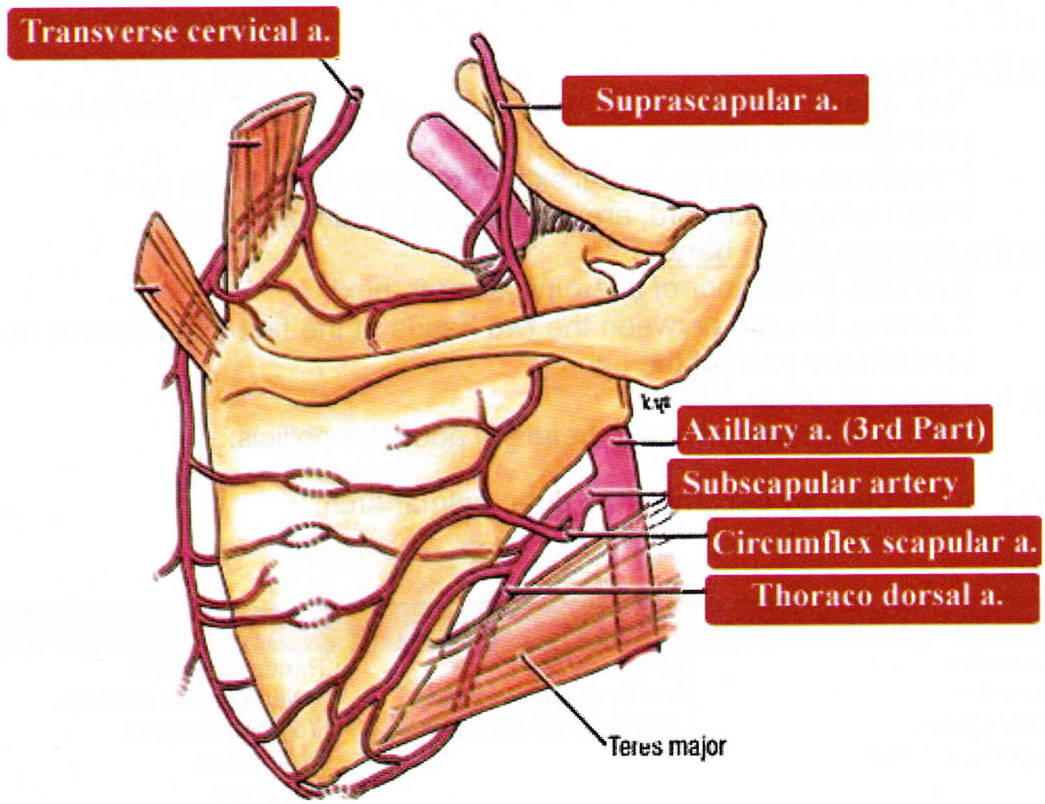
In the Forearm	At the Wrist	In the Hand
Radial Recurrent.	Dorsal Carpal.	Princeps Pollicis.
Muscular.	First Dorsal Metacarpal.	Volaris Indicis Radialis.
Volar Carpal.	Lateral dorsal digital	Volar Metacarpal.
Superficial Volar.		Perforating.
		Recurrent.



A. Anterior View

Vascular Anastomosis in Upper Limb

ANASTOMOSIS AROUND THE SCAPULA



1st part of the Subclavian artery

MCQ

Both arise from thyro-cervical trunk.

1. Supra-scapular artery.
2. Deep branches of transverse cervical artery.

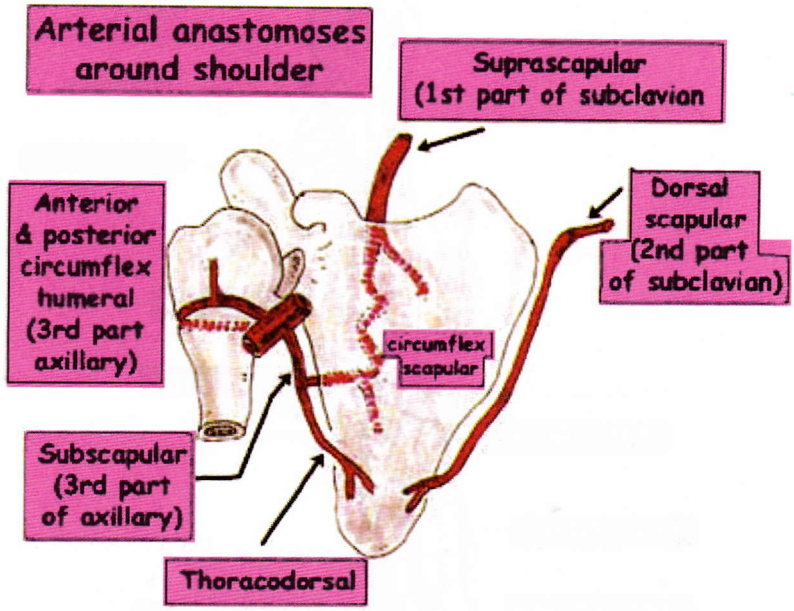
3rd part of the Axillary artery

MCQ

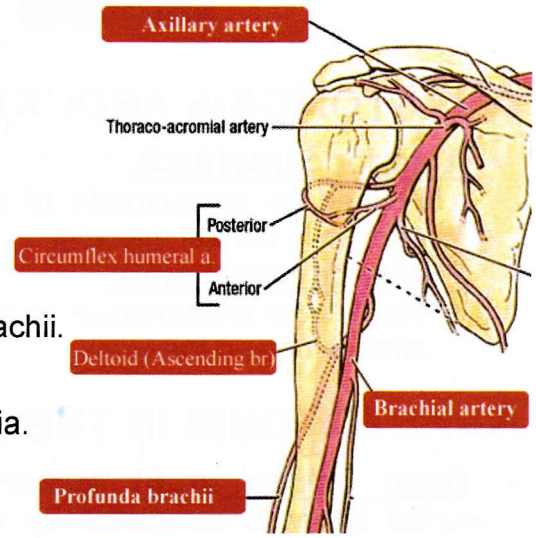
1. Sub-scapular artery.
2. Circumflex scapular artery (branch from sub-scapular artery).

SURGICAL IMPORTANCE:

- If there is obstruction of the subclavian artery, this anastomosis will be on duty (if the obstruction is between the 1st part of subclavian & 3rd part of axillary).
- If the obstruction is proximal to thyro-cervical trunk, with effort of the UL, vasodilatation occurs & blood shifts from vertebral artery to the UL through the anastomosis around the scapula or through the artery itself which will lead to syncopal attacks. This is called (**STEAL PHENOMENON**).



ANASTOMOSIS AROUND SURGICAL NECK OF HUMERUS



- **Axillary artery**
  - Anterior circumflex humeral artery.
  - Posterior circumflex humeral artery.
- **Brachial artery**
  - Ascending branches of Profunda brachii.

SURGICAL IMPORTANCE:

Used as collaterals in chronic ischemia.

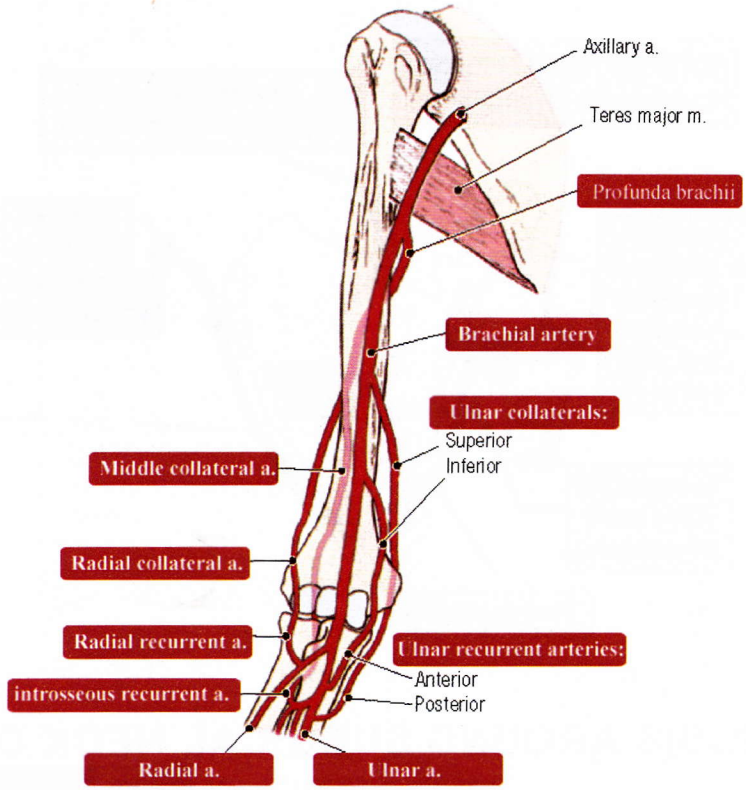
ANASTOMOSIS AROUND THE ELBOW

- **Around medial epicondyle:**

branches of brachial a. (superior ulnar collateral / inferior ulnar collateral) ⟷ anastomose with ⟷ (posterior ulnar recurrent / anterior ulnar recurrent) branches of ulnar a.

- **Around lateral epicondyle:**

branches of brachial a. (ant. des. br. of profunda / post. des. br. of profunda) ⟷ anastomose with ⟷ (radial recurrent a. from radial a. / post. interosseus recurrent a.from ulnar a.)

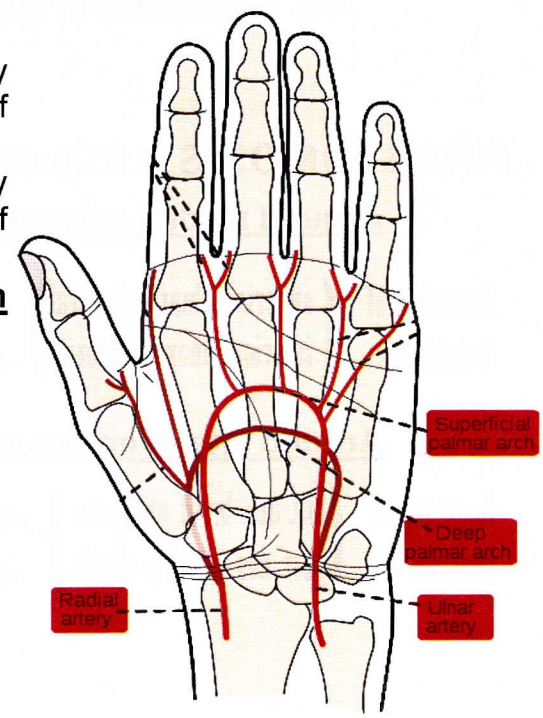


ANASTOMOSIS AROUND THE WRIST

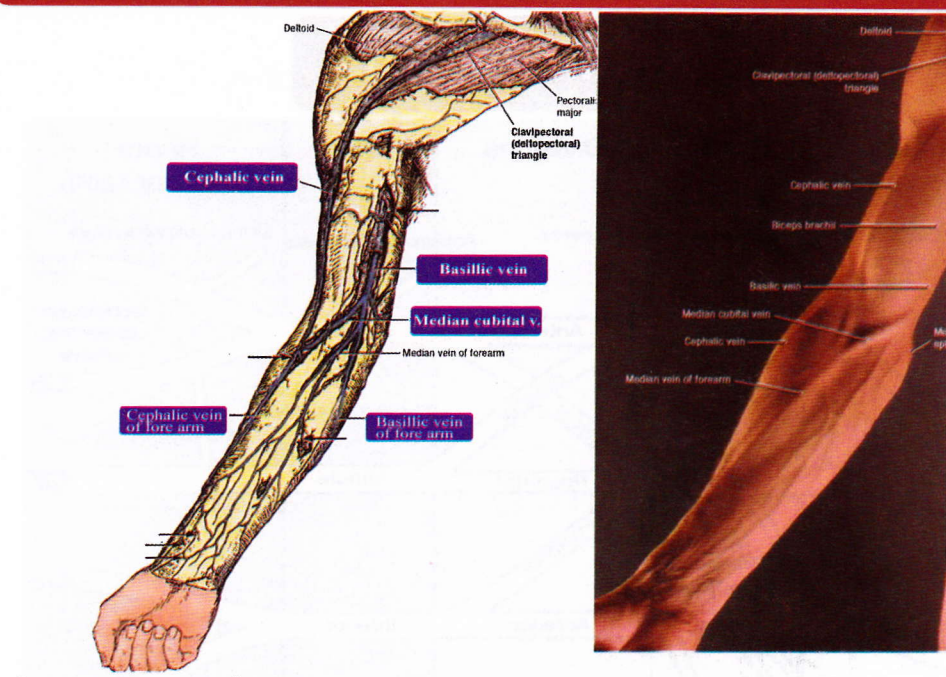
- **Anterior carpal arch:**
  Formed by anastomosis of the anterior carpal branches of radial & ulnar arteries in front of the wrist.
- **Posterior carpal arch:**
  Formed by anastomosis of the posterior carpal branches of radial & ulnar arteries behind the wrist.

ANASTOMOSIS IN THE HAND

- **Deep palmar arch:** formed mainly by radial artery & completed by a branch of ulnar artery.
- **Superficial palmar arch:** formed mainly by ulnar artery & completed by a branch of radial artery.
- **Anastomosis in the digits between digital arteries.**



Venous drainage of upper limb



Dorsal venous arch

- It lies across the lower part of the dorsum of the hand.
- It gives origin to both the cephalic & basilica veins from the lateral &medial ends of the venous arch respectively.

Cephalic vein

- It begins from the lateral ends of the dorsal venous arch & ascends on the lateral side of forearm.
- It reaches the front of the elbow joint where it communicates with the basilica vein through the median cubital vein.
- It ascends on the lateral margin of biceps & continues in delto-pectoral groove.
- It then pierces clavi-pectoral fascia to end in the axillary vein.

Basilic vein

- It begins from the medial ends of the dorsal venous arch & ascends on the medial side of forearm.
- As it passes in front of medial epicondyle it is joined by median cubital vein.
- It ascends along the medial margin of biceps brachii where it pierces the deep fascia opposite the insertion of coracobrachialis.
- It enters the axilla at the lower border of teres major to become the axillary vein.

Median cubital vein

- It lies obliquely in front of elbow where it joins the cephalic vein 1 inch below lateral epicondyle & joins the basilic vein 1 inch above the medial epicondyle.

Axillary vein

Course:

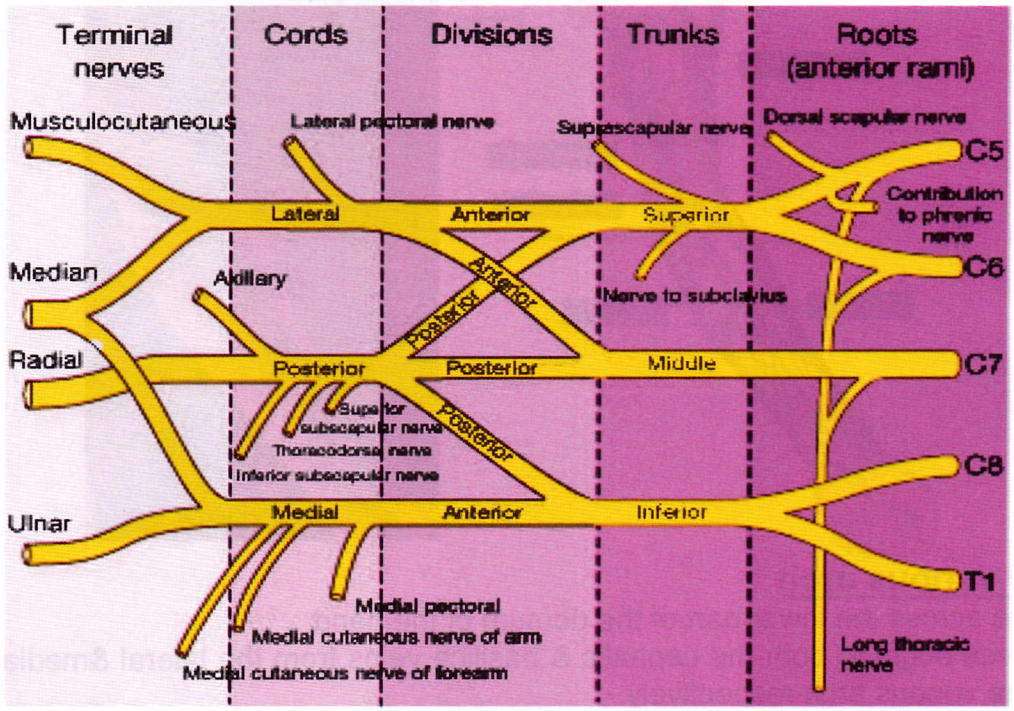
- **It begins at** the lower border of teres major as a continuation of basilica vein.
- **It ascends on** the medial side of the axillary artery.
- **It ends at** the outer border of the 1st rib by becoming the subclavian vein.

Tributaries:

1. 2 vena comitants which accompany the brachial artery.
2. Cephalic vein.
3. Veins which accompany the branches of the axillary artery.

Nerve supply of upper limb

Brachial Plexus



ROOTS: MCQ

- C5, 6, 7, 8 & T1.
- Posterior to scalenus anterior.

TRUNKS: (in the neck) MCQ

- **Upper trunk** → union of C5 & C6.
- **Medial trunk** → C7 alone.
- **Lower trunk** → union of C8 & T1.

DIVISIONS:

- Each trunk gives anterior & posterior divisions (behind middle ⅓ of the clavicle).
- Anterior division innervates the entire flexor compartment of UL. MCQ

CORDS: MCQ

In the axilla in relation to the axillary artery (named according to relations to 2nd part of axillary artery)

- **Lateral cord:** Formed by union of anterior division of upper & middle trunks (C5, 6, 7).
- **Medial cord:** Anterior division of lower trunk (C8, T1).

- **Posterior cord:**
  - It is formed by union of posterior division of all the trunks & has no contribution from anterior divisions.
  - It supplies all extensor ms of UL.

Branches of the Roots:

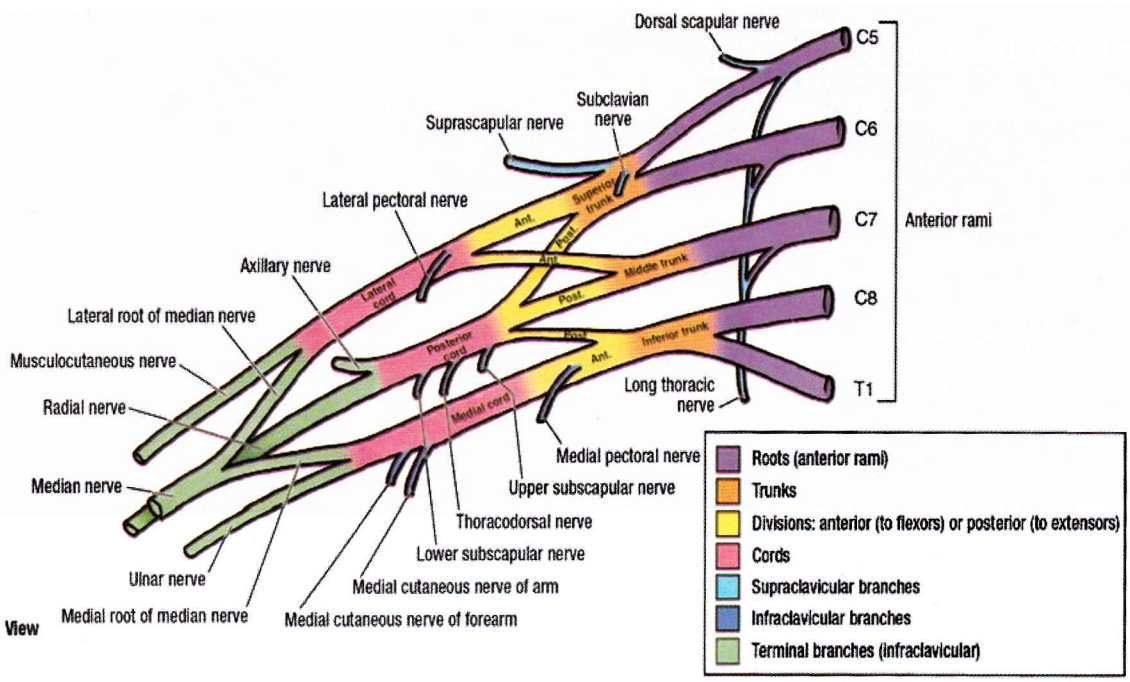
- Nerve to Rhomboids (C5).
- Nerve to Serratus anterior (Long thoracic N. of Bell) **(C5, 6, 7).** MCQ
- Root to phrenic nerve (C5).
- All roots → to scalene muscle & longus coli.

Branches of the Upper Trunk:

- Nerve to subclavius (C5, 6).
- **Supra-scapular Nerve.** (C5, 6). MCQ MCQ MCQ

Branches of the Lateral Cord	Branches of the Medial Cord	Branches of the Posterior Cord (ULNAR)
• Lateral pectoral nerve(C5,6,7) • Lateral root of median nerve (C5,6,7) • Musculo-cutaneous nerve (C5,6,7)	• Medial pectoral n. (C8, T1) • Medial root of median n. (C8, T1) • Med. cutaneous n. of the forearm (C8, T1) • Ulnar n. (C7,8, T1)	**U**: Upper sub-scapular n (C5, 6) **L**: Lower sub-scapular n (C5,6) **N**: N. to latissimus dorsi (C6,7,8) **A**: Axillary (circumflex) n. (C5,6) **R**: Radial n. (C5, 6, 7, 8, T1)

MCQ **N.B: C7 receives a gray ramus from the inferior cervical (or stellate) sympathetic ganglion**



SURGICAL IMPORTANCE (BRACHIAL PLEXUS INJURY):

Complete brachial plexus injuries → damage of all roots.

1. **Motor changes** → Affecting all muscles of the upper limb.
2. **Sensory changes** → Anesthesia of whole upper limb except:
   a) Medial side of arm (supplied by intercosto-brachial nerve).
   b) Skin over upper part of deltoid muscle (supplied by supra-clavicular nerve).
3. **Horner's syndrome** → due to sympathetic paralysis.

Upper trunk injury: (C5 - C 6) Erb-Duchenne paralysis

1- **Motor changes: → policeman's tip deformity**.
2- **Sensory changes** → anesthesia over the deltoid muscle.

Lower trunk injury (C8 - T1) Klumpke's paralysis

1. **Motor changes: → complete claw hand.**
2. **Sensory changes** → anesthesia along the medial aspect of the forearm & the medial 3½ fingers.
3. **Horner's syndrome** → due to sympathetic paralysis.

Medial cord injury leads to MCQ

- Paralysis of the long flexors of the fingers
- Paralysis of all the intrinsic muscles of the hand
- Loss of cutaneous sensation over anterior surface of palm & fingers

Thoracic outlet syndrome: involves C8-T1 MCQ

The Phrenic nerve: MCQ

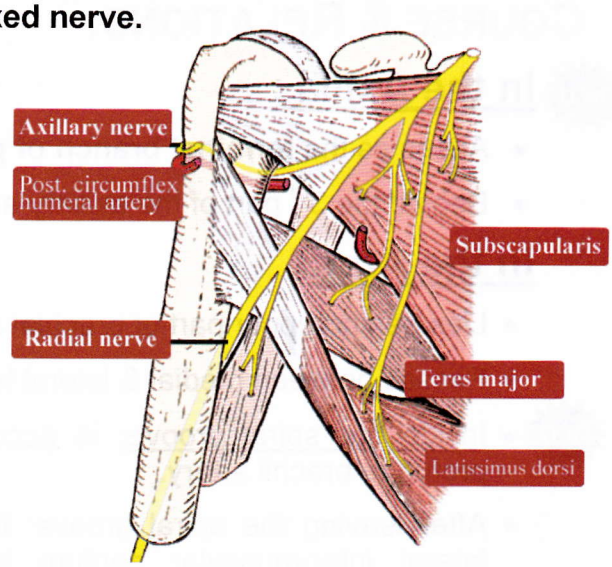
- It is a branch of the cervical plexus (C3,4,5 - mainly C4)
- Course:
  - At the base of the neck it lies
    - Anterior to scalene muscles
    - Deep to the pre-vertebral fascia.
  - They enter the chest by passing
    - Superficial to subclavian artery.
    - Crosses anterior to the internal thoracic artery.
  - It runs anterior to the root of lung

Axillary (Circumflex) Nerve

It is a mixed nerve.

COURSE & RELATIONS:

- **Arises** from the posterior cord of brachial plexus (C5, 6) behind the 3rd part of the axillary artery.
- **Passes** backwards through the quadrangular space then around the surgical neck of the humerus.



SURGICAL IMPORTANCE: (AXILLARY NERVE INJURY):

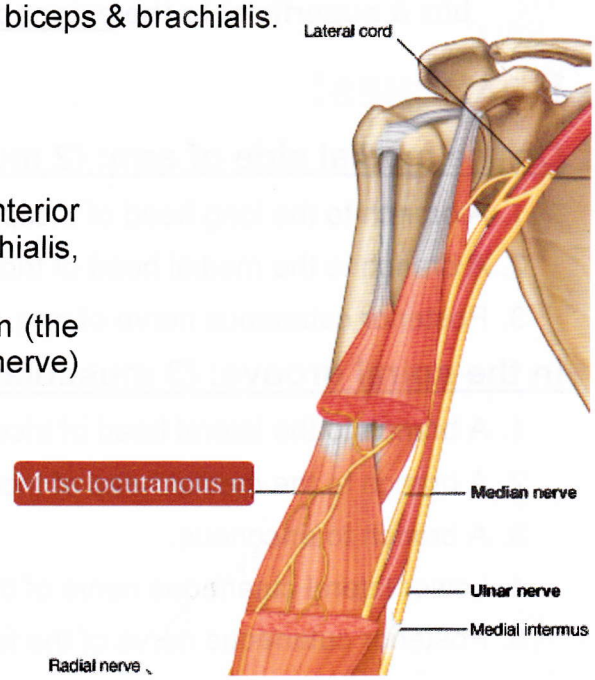
- **Motor**: paralysis of deltoid & teres minor.
- **Sensory**: loss of skin sensations over lateral ½ of deltoid.
- **Deformity**: flat shoulder.

Musculo-cutaneous Nerve

It is a mixed nerve from the lateral cord

COURSE & RELATIONS:

- Lateral to the 3rd part of Axillary artery.
- Leaves the axilla by **piercing the coracobrachialis m.** MCQ
- Then descends downwards between biceps & brachialis.



BRANCHES: MCQ

- It supplies all muscles of the anterior compartment of the arm (coracobrachialis, biceps & brachialis).
- Lateral cutaneous nerve of the forearm (the continuation the musculo-cutaneous nerve) → sensory to the lateral ½ of forearm.

Radial Nerve

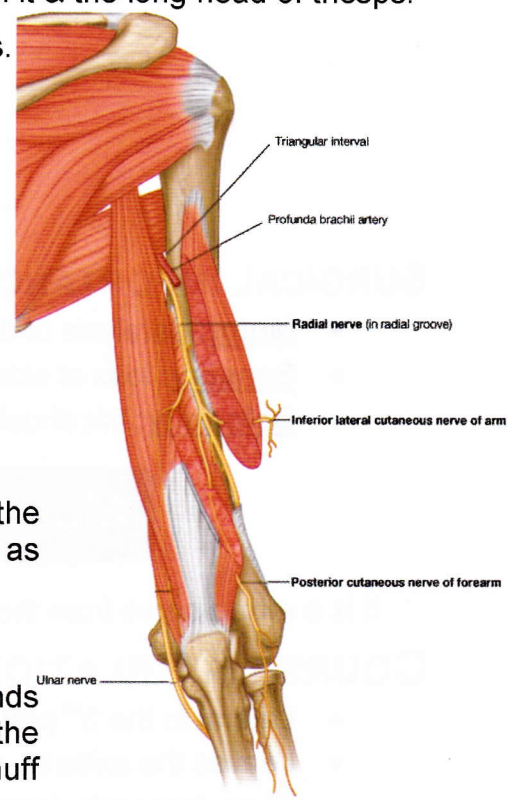
COURSE & RELATIONS:

In the Axilla :

- Arises as the **terminal branch of posterior cord** (C5, 6, 7, 8 & T1).
- Behind the 3rd part of the axillary artery.

In the Arm:

- Lies behind upper part of brachial artery, between it & the long head of triceps.
- Passes between medial & lateral heads of triceps.
- Inside the spiral groove: is accompanied by profunda brachii artery.
- After leaving the spiral groove: it pierces the lateral inter-muscular septum to enter the anterior compartment on the lateral side of the arm.
- Here, the nerve lies deeply in the groove between the brachialis & brachioradialis.



In the Forearm & Hand:

- **In front of** the lateral epicondyle it gives the **posterior interosseous** & continues downwards as the superficial radial nerve.
- It passes deep to brachioradialis.
- About 5 cm above the wrist, the nerve winds **around the lateral side of radius** to reach the back of the hand crossing over the anatomical snuff box & **superficial to the extensor retinaculum.**

BRANCHES:

On the medial side of arm: (2 muscular & one cutaneous):

1. A branch to the long head of triceps: arises in the axilla.
2. A branch to the medial head of triceps.
3. Posterior cutaneous nerve of arm: to skin of the back of the arm.

In the spiral groove: (3 muscular & 2 cutaneous):

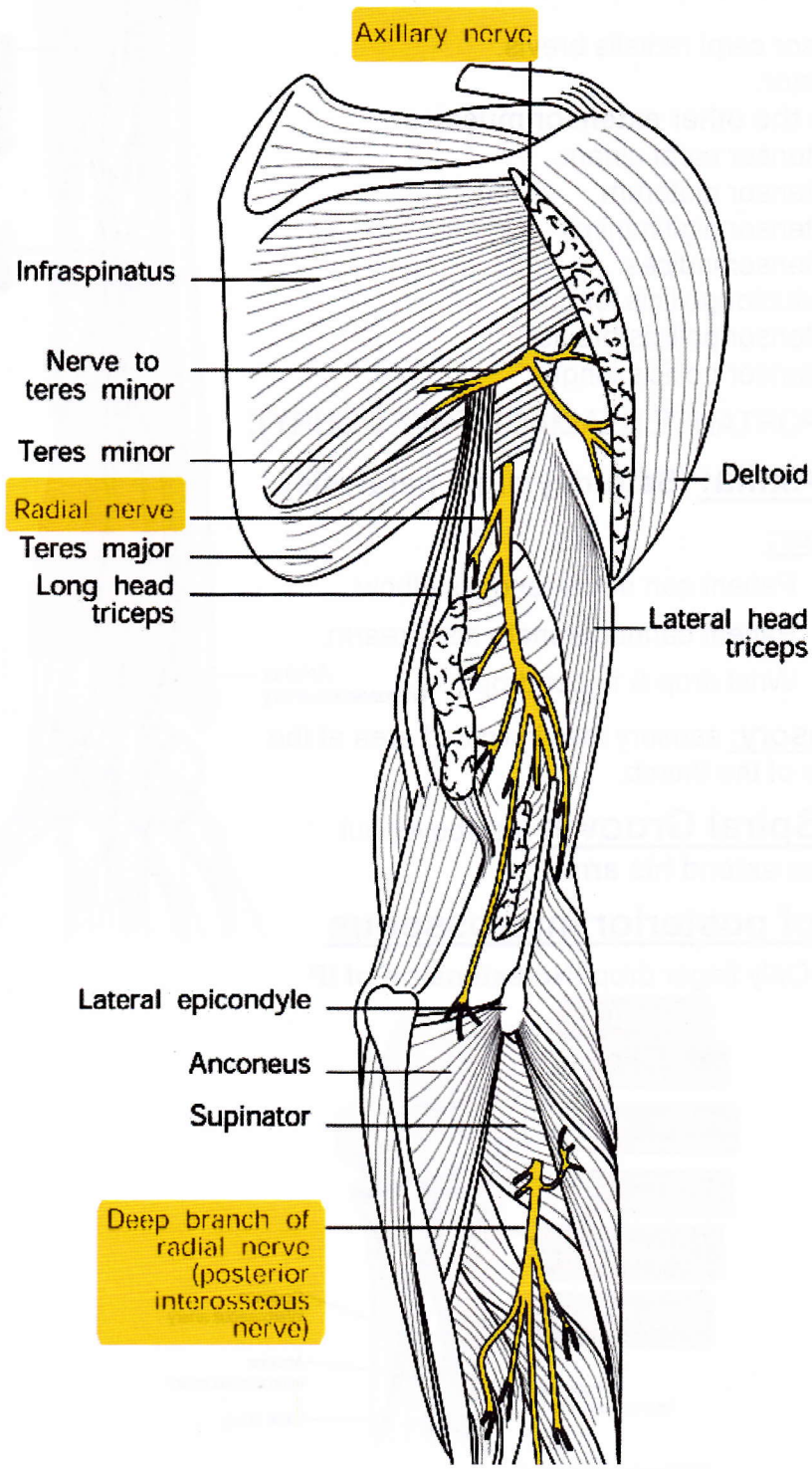
1. A branch to the lateral head of triceps.
2. A branch to the medial head of triceps (so the medial head has 2 branches).
3. A branch to anconeus.
4. Lower lateral cutaneous nerve of the arm.
5. Posterior cutaneous nerve of the forearm.

On the lateral side of the arm: (3 muscular)

1. A branch to brachioradialis.
2. A branch to extensor carpi radialis longus.
3. A branch to lateral part of brachialis.

In the forearm & hand: MCQ

1. Posterior interosseous nerve.
2. Dorsal digital branches: to supply the skin of the lateral ⅔ of the dorsum of the hand & dorsum of the lateral 3 fingers as far as the distal IP joints.

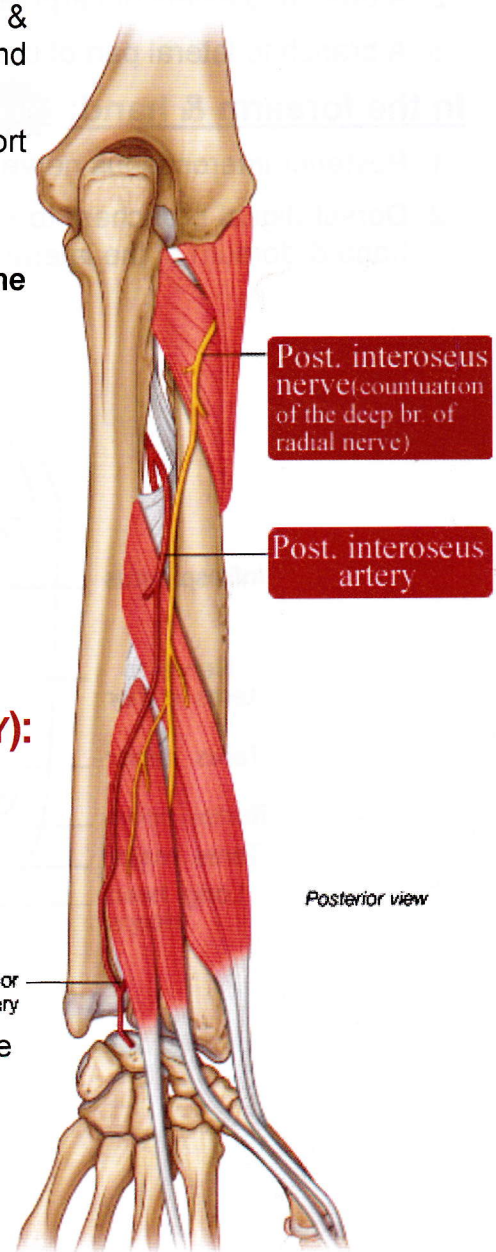


Posterior Interosseous Nerve

- It descends under cover of the brachioradialis & **pierces the supinator** through which it winds around the lateral side of the radius.
- It appears on the back of the forearm, a short distance above the lower border of the supinator.

Branches:

- **It supplies 2 muscles before piercing the supinator:**
  1. Extensor carpi radialis brevis.
  2. Supinator.
- **It supplies the other extensor muscles**:
  1. Extensor carpi ulnaris.
  2. Extensor didtorum.
  3. Extensor digitiminimi.
  4. Extensor indices.
  5. Abductor pollicis longus.
  6. Extensor pollicis brevis.
  7. Extensor pollicis longus.



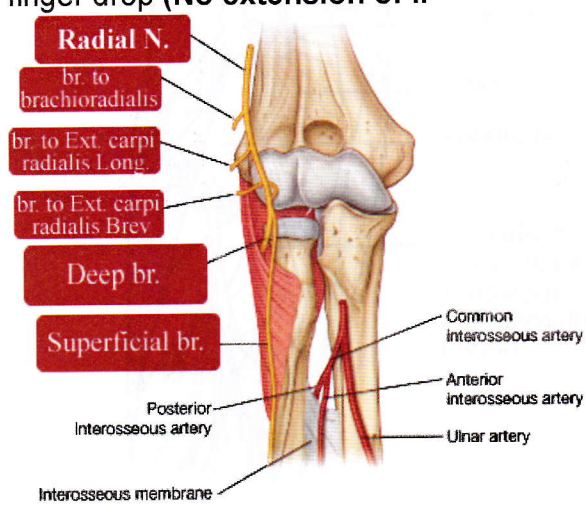
SURGICAL IMPORTANCE (RADIAL NERVE INJURY):

In the Axilla: (Saturday night paralysis)

- **Motor:**
  - Patient can not extend his elbow.
  - Patient cannot pronate his forearm.
  - Wrist drop & finger drop.
- **Sensory**: sensory loss in limited area at the base of the thumb.

In the Spiral Groove: as above, but patient **can extend his arm**.

Injury of posterior interosseous nerve: Only finger drop **(No extension of IP joints)**

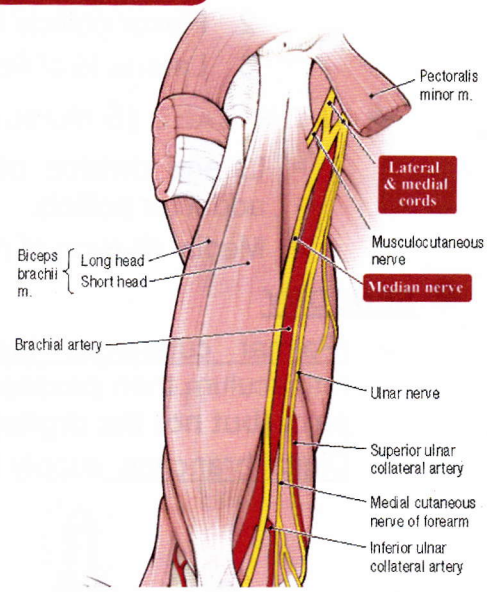


Median Nerve

COURSE & RELATIONS:

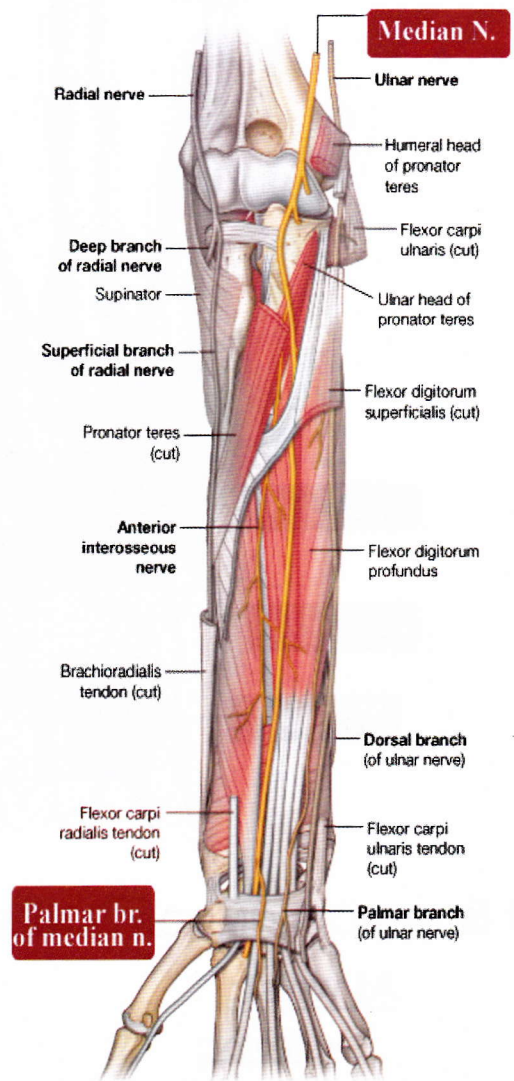
In the axilla & arm:

- It arises in the axilla by 2 braches from medial cord & lateral cord of brachial plexus (C5, C6, 7, 8 & T1).
- It crosses in front of the brachial artery from lateral to medial.
- It lies medial to biceps, anterior to brachialis & triceps.



In the forearm:

- In the cubital fossa, it passes:
  1. Medial to the brachial artery.
  2. In front of insertion of brachialis.
- It leaves the cubital fossa by passing between 2 heads of pronator teres.
- It passes deep to flexor digitorum superficialis where it is adherent to its undersurface & runs in front of flexor digitorum profundus.
- About 5 cm above the wrist: it lies in the interval between flexor carpi radialis (laterally) & palmaris longus (medially).



In the hand:

- The nerve enters the carpal tunnel immediately **under cover of the flexor retinaculum**.
- **It terminates** Just distal to the flexor retinaculum, by dividing into lateral & medial divisions each of which gives off palmar digital branches.

BRANCHES:

MOTOR

IN THE FOREARM:

- 4 superficial flexor muscles
  1. Pronator teres.
  2. Flexor carpi radialis.
  3. Palmaris longus.
  4. Flexor digitorum superficialis.

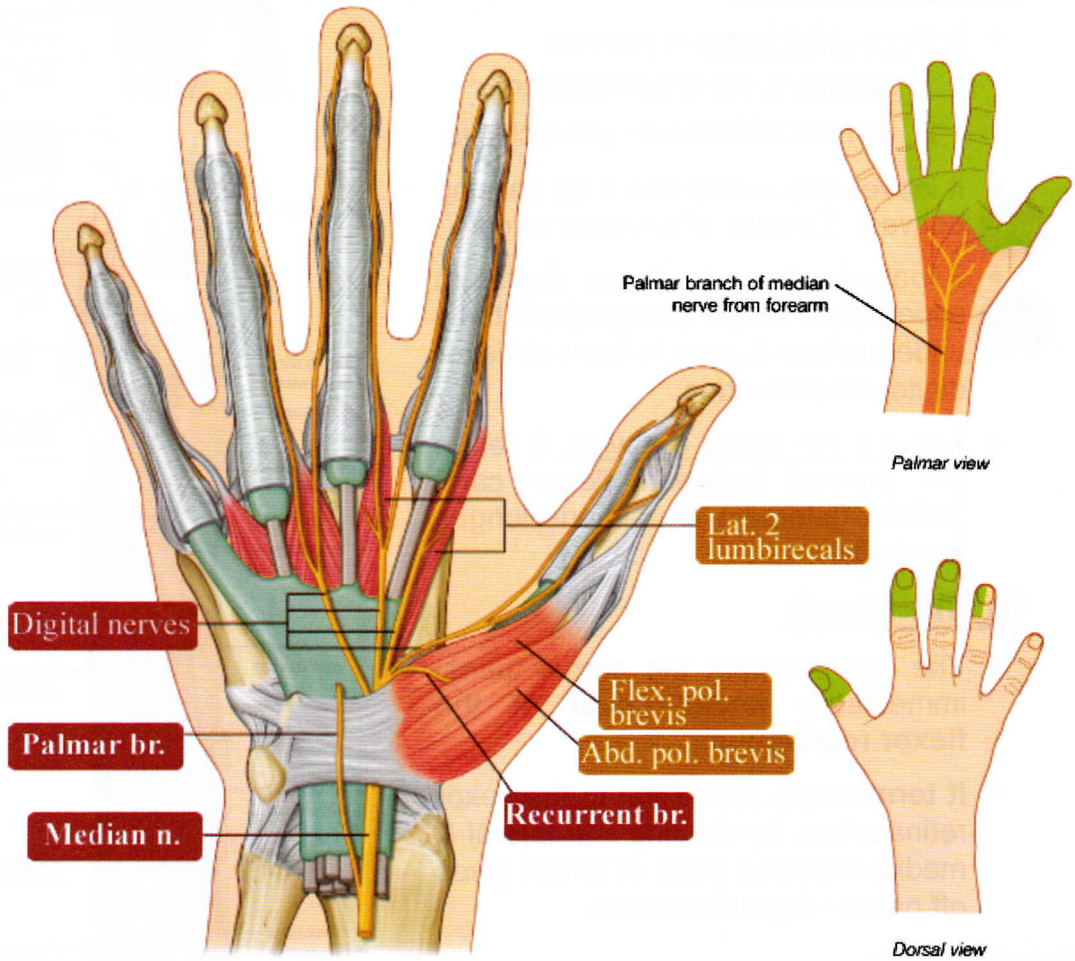
- The anterior interosseus N. → 2½ muscles
  1. Pronator quadrates.
  2. Flexor pollicis longus.
  3. Lateral ½ of flexor digitorum profundus.

IN THE HAND (5 MUSCLES).

- Lateral division of median N. supplies all thenar muscles, except adductor pollicis.
- Medial division of median N. supplies lateral 2 lumbrical muscles.

SENSORY

- (Palmar cutaneous branch): arises about 5 cm above the flexor retinaculum then passes in front of it to supply skin of the lateral ⅔ of the palm **(but not the digits)**.
- Digital branches: supply the plamar surface of lateral 3½ fingers.



MCQ SURGICAL IMPORTANCE (MEDIAN NERVE INJURY):

At wrist:

- **Motor:**
  - → Wasting of thenar eminence.
  - → Loss of opposition.
  - → Weakness of abduction of the thumb.

- **Sensory:** sensory loss over
  - → Lateral ⅔ of palmar surface of the hand.
  - → Lateral 3½ fingers (palmar surface).

MCQ

- **Deformity**: **Ape hand deformity**

MCQ **At elbow:** As above + ulnar deviation + positive clasping test.

N.B: Carpal tunnel syndrome (see neurosurgery)

Ulnar Nerve

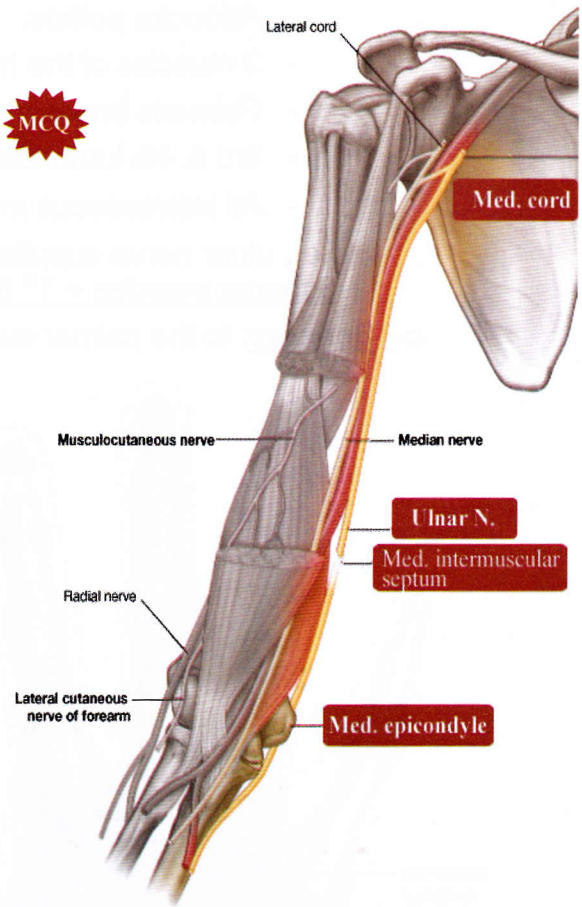
COURSE & RELATIONS:

In the axilla & arm:

MCQ

- It arises as the **termination of medial cord** of brachial plexus between 3rd part of axillary artery & axillary vein.
- It descends medial to brachial artery till the insertion of coracobrachialis where it deviates medially & downwards to pierce the medial inter-muscular septum, to **reach the posterior compartment of the arm**.

MCQ



In the forearm:

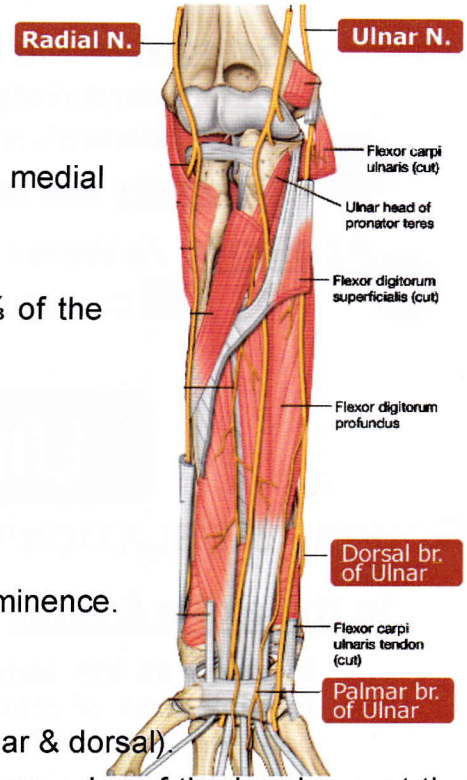
MCQ

- It enters the forearm by passing **behind the medial epicondyle.**
- It passes between the 2 heads of **flexor carpi ulnaris,** & descends along the medial side of forearm **between flexor carpi ulnaris & flexor digitorum profundus**.
- Continues downwards **superficial** to the flexor retinaculum.

In the hand:

- Terminates just lateral to pisiform bone by dividing into superficial & deep branches.

BRANCHES: MCQ



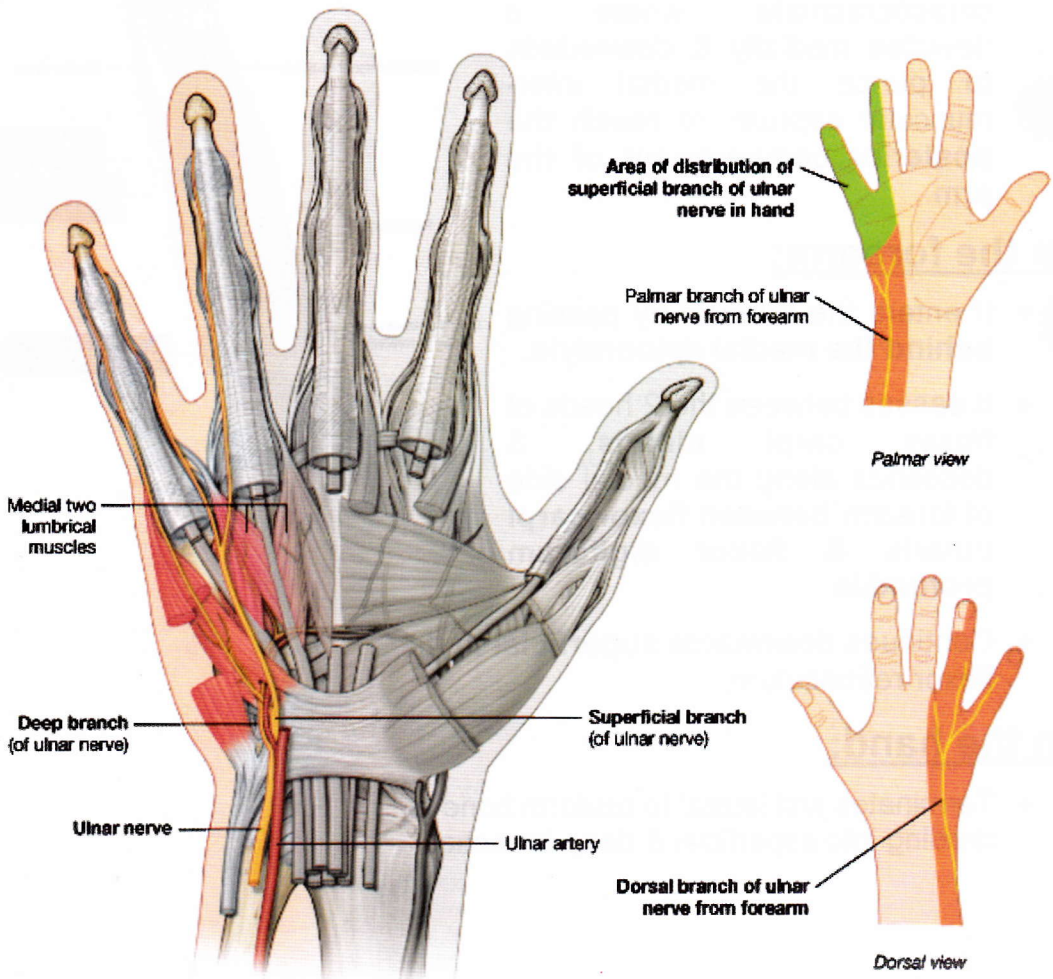
In the forearm:

- **Motor:** to supply flexor carpi ulnaris + medial ½ of flexor digitorum profundus.
- **Sensory**:
  - Medial ⅓ of the palm & medial ⅓ of the back of the hand.
  - Back of the medial 1½ fingers.

In the hand:

- **Motor:**
  - Adductor pollicis.
  - 3 muscles of the hypothenar eminence.
  - Palmaris brevis muscle.
  - 3rd & 4th lumbricals.
  - All interosseous muscles (palmar & dorsal).

  i.e., ulnar nerve supplies all intrinsic muscles of the hand except the 3 thenar muscles + 1st & 2nd lumbricals.
- **Sensory**: to the palmar surface of the medial 1½ finger.

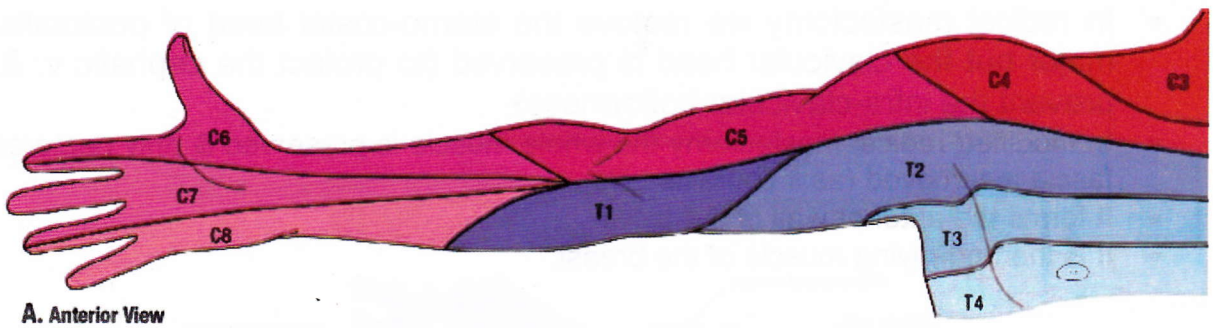


SURGICAL IMPORTANCE (ULNAR NERVE INJURY):

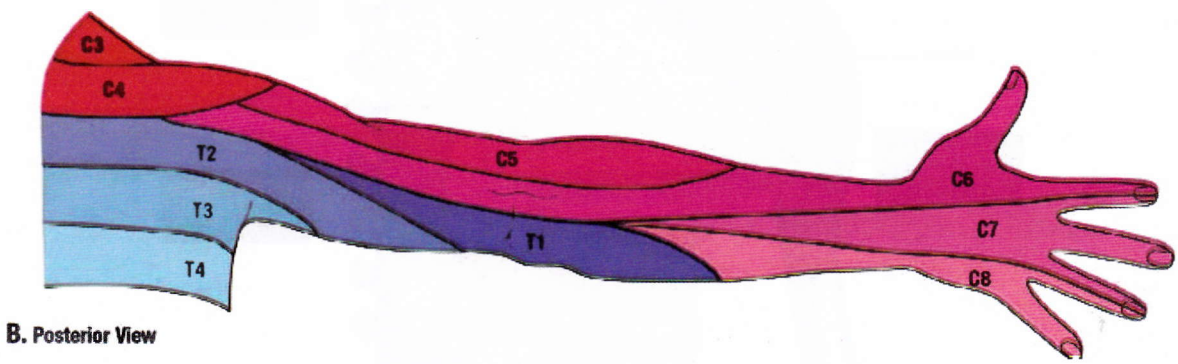
At wrist:

- **Motor:**
  - → Wasting of hypothenar eminence.
  - → Partial claw hand.
  - → +ve Froment's test.
  - → +ve card test + loss of abduction.
  - → Guttering between metacarpal bones.
- **Sensory:** sensory loss over:
  - → Medial ⅓ of the palm.
  - → Medial 1½ fingers.

At elbow: As above + loss of ulnar deviation + ulnar paradox.



A. Anterior View



B. Posterior View

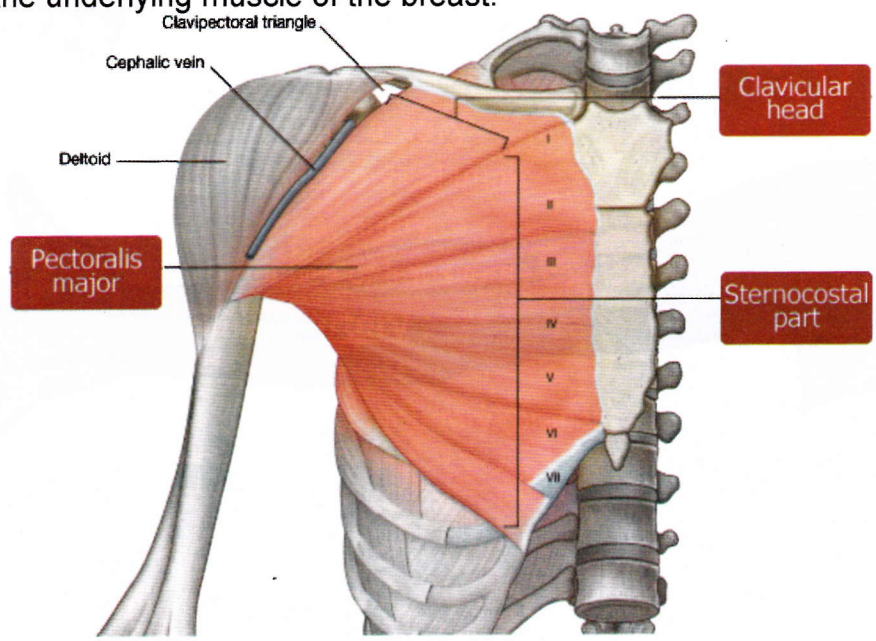
Muscles of the shoulder region

PECTORALIS MAJOR MCQ

Origin	Insertion	N. Supply	Action
Clavicular head: med ½ of front of clavicle **Sternocostal head:** anterior surface of the sternum, upper 6 costo-chondral junctions & Ext. oblique aponeurosis.	Lateral lip of the bicipital groove of humerus	Medial & lateral Pectoral nerves	Flexion, adduction & rotates arm medially

SURGICAL IMPORTANCE:

- In radical mastectomy we remove the sterno-costal head of pectoralis major but the clavicular head is preserved (to protect the cephalic v. & prevent the infra-clavicular hollowness).
- In modified radical mastectomy the whole muscle is preserved & only pectoral fascia is removed (as it contains LNs).
- It forms the anterior wall of the axilla.
- It is the underlying muscle of the breast.

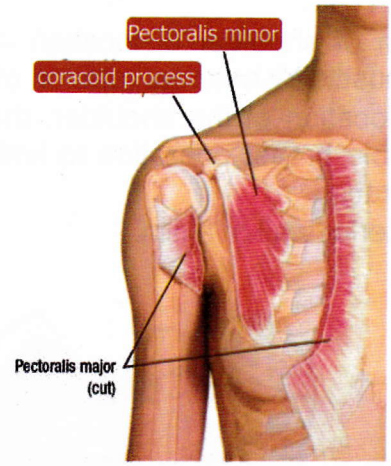


PECTORALIS MINOR MCQ

Origin	Insertion	N. Supply	Action
3rd, 4th & 5th ribs	Coracoid process of scapula	Medial pectoral nerve	Protraction (draws scapula forwards)

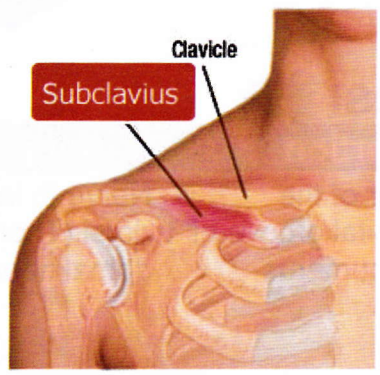
SURGICAL IMPORTANCE:

- It divides axillary artery into 3 parts.
- It is removed in radical mastectomy to open the axilla (it is the door of the axilla).
- It is retracted or cut for clearance of axilla in MRM.



SUBCLAVIUS

Origin	Insertion	N. Supply	Action
1st costo-chondral junction	Lower surface of the middle ½ of clavicle	Nerve to subclavius	Holds clavicle in place

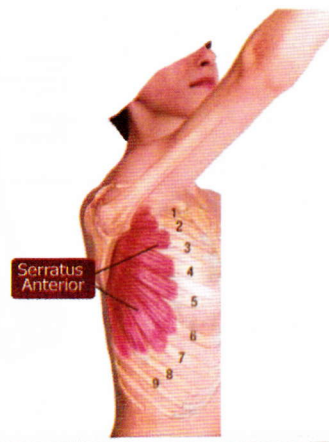


MCQ SERRATUS ANTERIOR

Origin	Insertion	N. Supply	Action
8 digitations from the outer surface of upper 8 ribs	Medial border of the scapula (ventral surface)	Nerve to serratus ant (N. of bell) {long thoracic n.}	Protraction & rotation of the scapula (90°-180°)

SURGICAL IMPORTANCE:

- Nerve to serratus anterior should be preserved during radical mastectomy.
- Injury to n. of Serratus anterior leads to winging of the scapula.

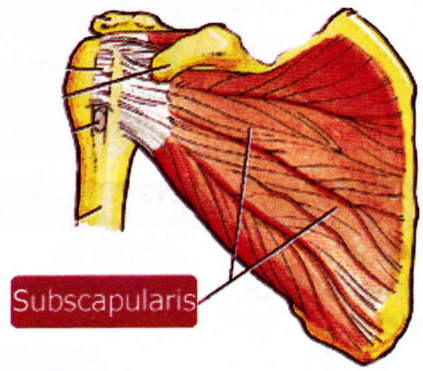


SUBSCAPULARIS

Origin	Insertion	N. Supply	Action
Sub-scapular fossa	Lesser tuberosity of the humerus	Upper & lower sub-scapular Nerves	Medial rotation & adduction of arm.

SURGICAL IMPORTANCE:

- During reduction of shoulder dislocation → we overcome the spasm of subscapularis muscle by external rotation of the arm (Kocher's method).
- In recurrent dislocation of the shoulder, the subscapularis tendon should be fixed by double breast operation to limit abduction & external rotation (putti-plate) operation.
- It forms the posterior wall of axilla.

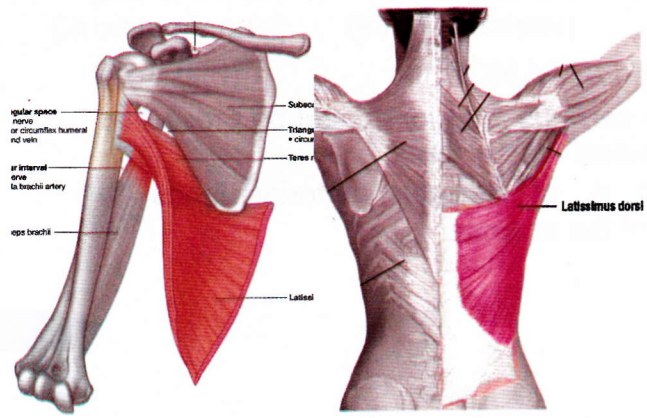


LATISSIMUS DORSI MCQ

Origin	Insertion	N. Supply	Action
Lower 6 thoracic spines, lumbar fascia, iliac crest, lower 8 ribs & inferior angle of scapula	Floor of the bicipital groove of the humerus	Nerve to latissimus dorsi (Thoraco-dorsal nerve)	Adduction of the arm. Used in climbing & swimming.

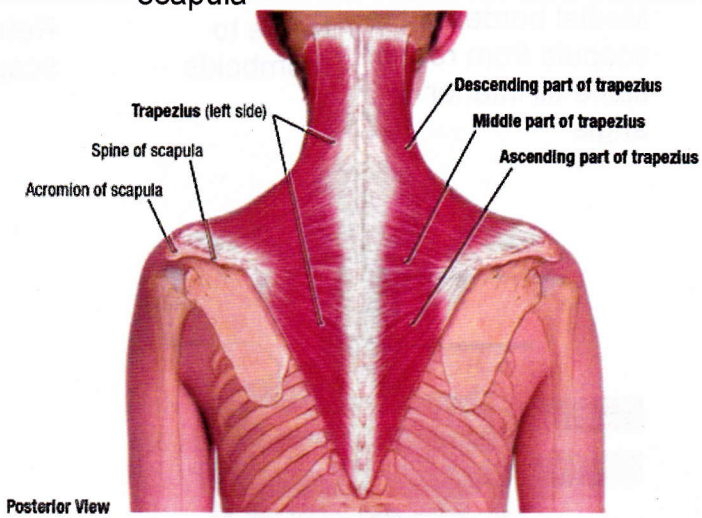
SURGICAL IMPORTANCE:

During mastectomy, we preserve the nerve to Latissimus dorsi to use the muscle in mammoplasty



TRAPEZIUS MCQ

Origin	Insertion	N. Supply	Action
- external occipital protuberance - Superior Nuchal line - ligamentum nuchae - 7th cervical spine - spines of all thoracic vertebrae	- Post. Border of lat. ⅓ of clavicle - Med. Border of acromion - Upper lip of spine of scapula	Spinal root of accessory nerve	Retraction, elevation of the shoulder & rotation of scapula (90°-180°)

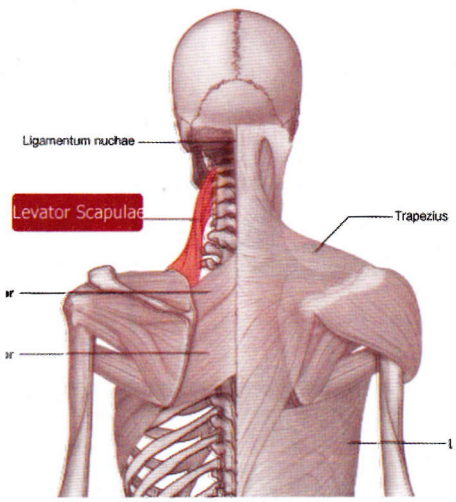


SURGICAL IMPORTANCE: Its paralysis → shoulder drop.

It is the only muscle in upper limb which is not supplied by brachial plexus.

LEVATOR SCAPULAE MCQ

Origin	Insertion	N. Supply	Action
Transverse processes of the upper 4 cervical vertebrae.	Medial border of the scapula from superior angle to the root of the spine	Nerve to rhomboids	Elevation of the medial end os scapula

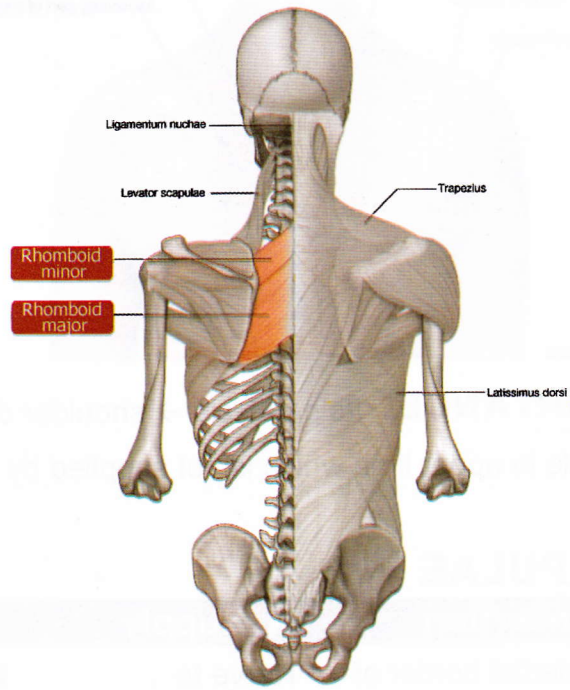


RHOMBOIDUS MINOR

Origin	Insertion	N. Supply	Action
7^{th} cervical spine & 1^{st} thoracic spine	Medial border of the scapula opposite to the root of the spine	Nerve to rhomboids	Retraction of the scapula

RHOMBOIDUS MAJOR

Origin	Insertion	N. Supply	Action
2^{nd}, 3^{rd}, 4^{th} & 5^{th} thoracic spines	Medial border of the scapula from root of spine till inferior angle	Nerve to rhomboids	Retraction of the scapula



SUPRASPINATUS

Origin	Insertion	N. Supply	Action
Supra-spinous fossa in scapula	Upper impression of the greater tuberosity of humerus	Supra-scapular Nerve	Initiation of abduction (0°-30°) Stabilization of shoulder joint.

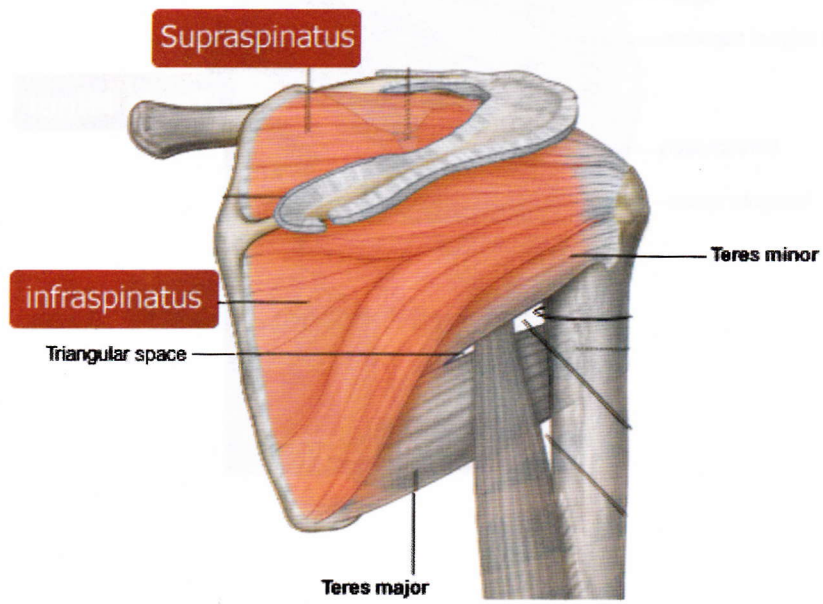
SURGICAL IMPORTANCE:

- Supraspinatus tendenitis.
- Rupture of supinatus tendon.

INFRASPINATUS

Origin	Insertion	N. Supply	Action
Infra-spinous fossa of scapula	Middle impression of the greater tuberosity	Supra-scapular Nerve	Lateral rotation & adduction Stabilization of shoulder joint.

N.B: Supra-scapular nerve passes through the supra-scapular notch MCQ



TERES MINOR

Origin	Insertion	N. Supply	Action
Upper ⅔ of lateral border of the scapula (dorsal)	Lower impression of the greater tuberosity of humerus	Axillary Nerve (circumflex Nerve)	Lateral rotation & adduction of shoulder.

TERES MAJOR

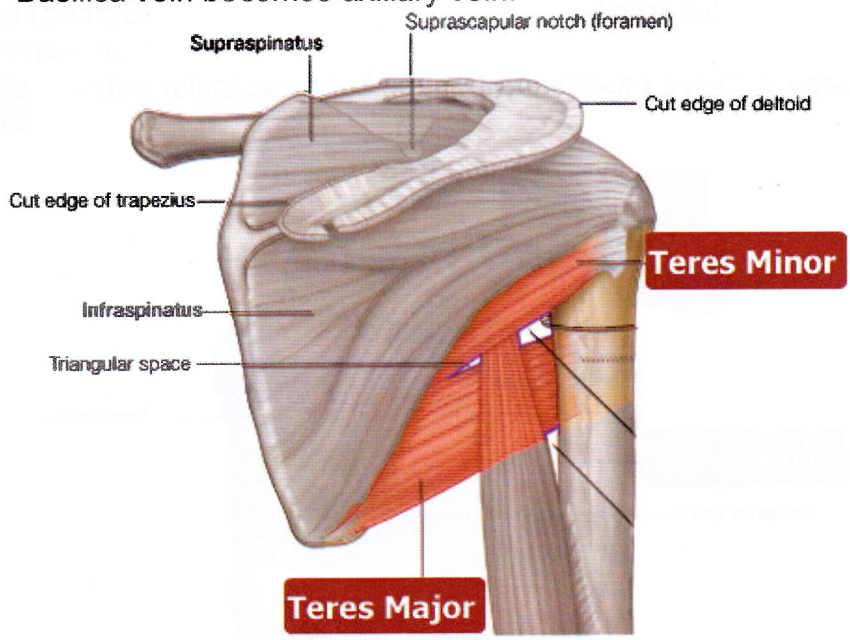
Origin	Insertion	N. Supply	Action
Lower ⅓ of lateral border of the scapula (dorsal)	Medial lip of the bicipital groove	Lower sub-scapular Nerve	Adduction, extension & medial rotation

SURGICAL IMPORTANCE:

At the lower border of teres major = lower limit of axilla.

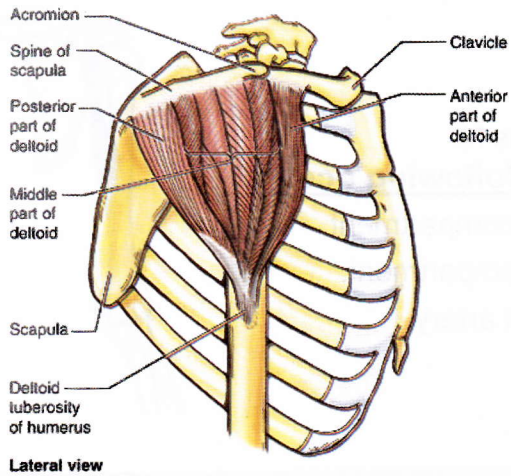
MCQ

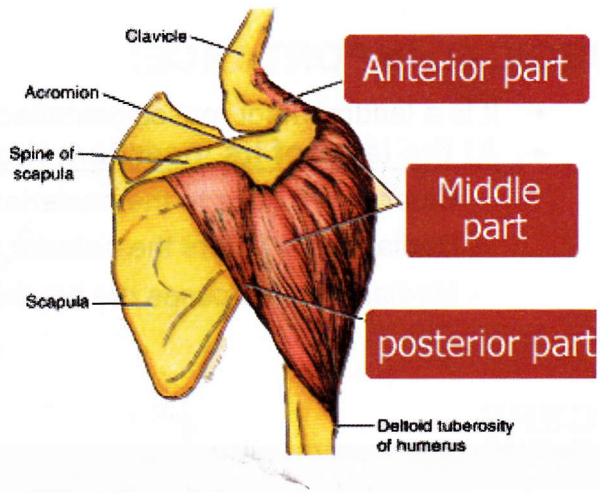
- Axillary artery becomes brachial artery.
- Basilica vein becomes axillary vein.



DELTOID

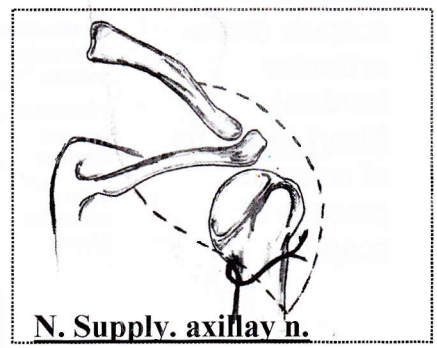
Origin	Insertion	N. Supply	Action
Ant. Border of Lateral ⅓ of clavicle Lateral border of acromion Crest of the spine of the scapula	Deltoid tuberosity of the humerus	Axillary Nerve (circumflex N)	Extension & lateral rotation of the arm.





N.B.

- **Deltoid is multi-pinnate.**
- Injury of axillary nerve → paralysis of deltoid (flat shoulder deformity + failure of abduction from 15 -90) & loss of sensation over its lateral ½.

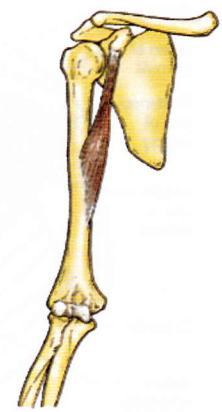


Muscles of the Arm

Front of the Arm

CORACOBRACHIALIS

Origin	Insertion	N. Supply	Action
Tip of coracoid process (with short head of biceps)	Deltoid tuberosity of the humerus	**Musculo-cutaneous Nerve**	Flexion of the arm



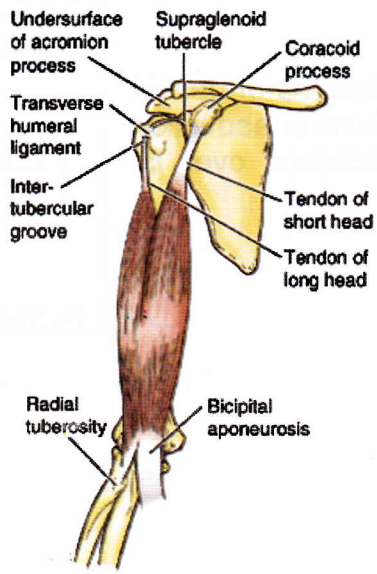
SURGICAL IMPORTANCE:

- It is a landmark for musculocutaneous N.
- **<u>At the level of its insertion, the following occurs:</u>**
  - Ulnar nerve goes to the posterior compartment.
  - Radial nerve enters the anterior compartment.
  - Median nerve crosses the brachial artery.

MCQ

BICEPS

Origin	Insertion	N. Supply	Action
<u>Long head:</u> supra-glenoid tubercle of scapula (**intra-articular tendon**) **<u>Short head</u>**: tip of coracoid process of scapula.	Radial tuberosity & bicipital aponeurosis	Musculo-cutaneous nerve	Supination & flexion of elbow & shoulder



SURGICAL IMPORTANCE:

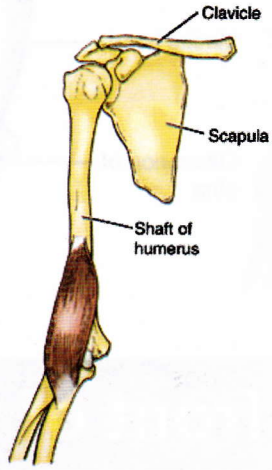
- Rupture of biceps tendon → pop eye deformity:
  - Diagnosed on flexion of the elbow against resistance, where the affected muscle bunches distally leaving a gape proximally.
- Bicipital aponeurosis separates the brachial A. from median cubital V.
- Biceps tendon reflex.

BRACHIALIS

Origin	Insertion	N. Supply	Action
Front of the lower ½ of the humerus. Med. & lat. Inter-muscular septum.	Ulnar tuberosity	Musculo-cutaneous & radial nerves (Double N. supply)	Main Flexion of the elbow joint

SURGICAL IMPORTANCE: Myositis ossificans.

MCQ



Back of the Arm

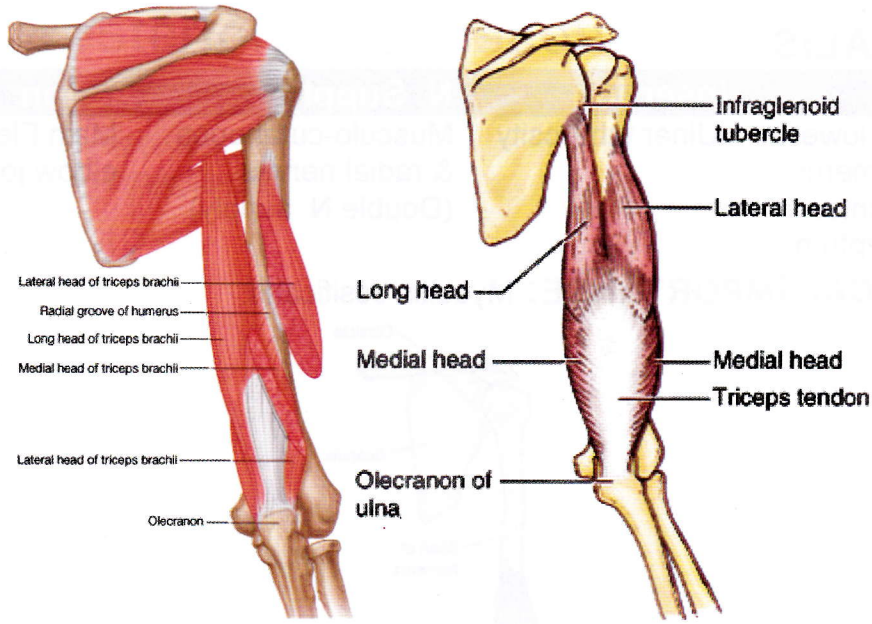
MCQ

TRICEPS

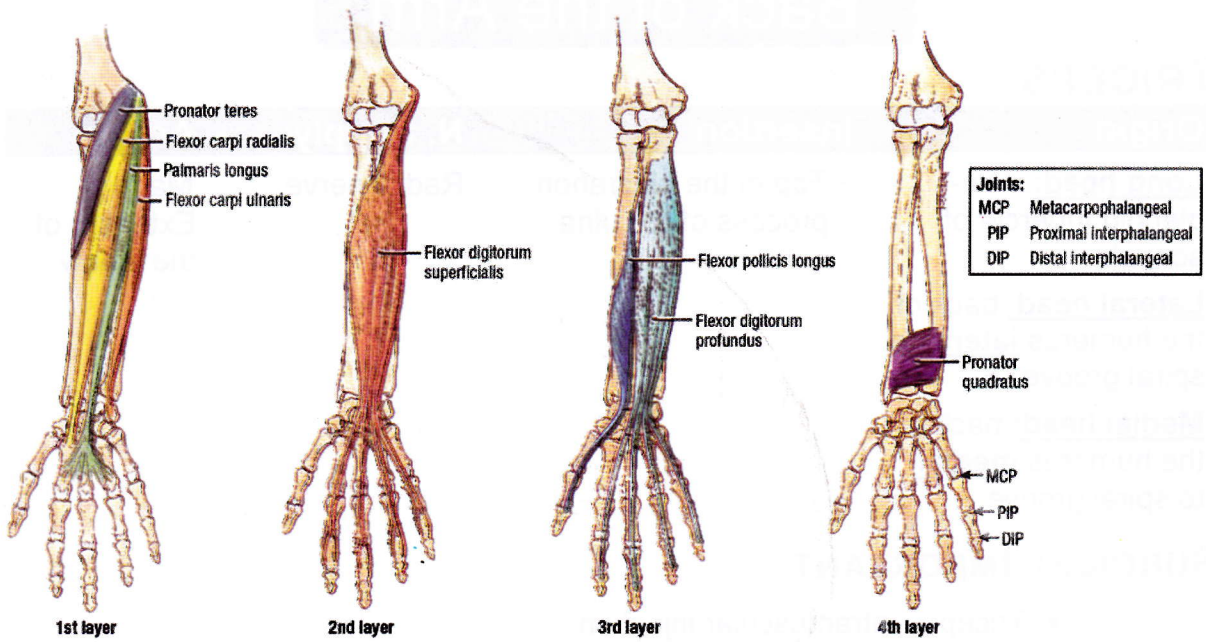
Origin	Insertion	N. Supply	Action
Long head: infra-glenoid tubercle of scapula. **Lateral head**: back of the humerus **lateral** to spiral groove **Medial head:** back of the humerus **medial** to spiral groove	Top of the olecranon process of the ulna	Radial nerve	Main Extensor of the elbow

SURGICAL IMPORTANT:

- Triceps: intramuscular injection.
- Fracture dislocation around elbow.
- Triceps tendon reflex.

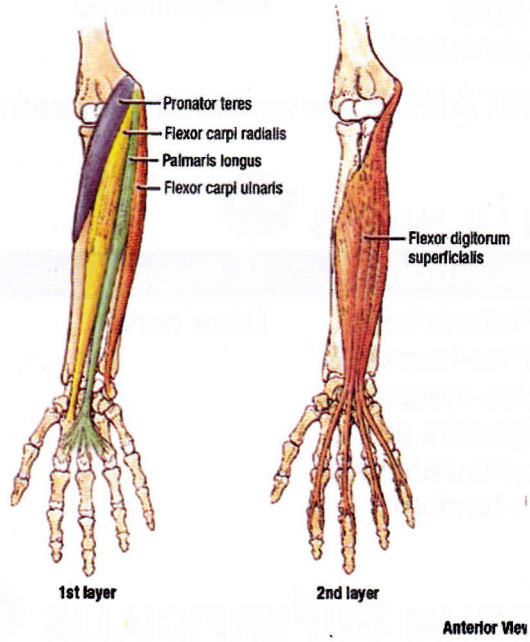


Muscles of the front of the forearm



Anterior Views

Superficial group



- **<u>These include:</u>**
  - Pronator teres.
  - Flexor carpi radialis.
  - Palmaris longus.
  - Flexor carpi ulnaris.
  - Flexor digitorum superficialis.

MCQ

- **<u>They arise by</u>** a common tendon from the front of medial epicondyle of humerus (common flexor origin).
- **<u>They are flexors of the elbow joint.</u>**
- All are supplied by **<u>median nerve</u>** except flexor carpi ulnaris by **<u>ulnar nerve.</u>**

PRONATOR TERES

Origin	Insertion	N. Supply	Action
<u>Humeral head:</u> CFO. (front of medial epicondyle of the humerus) <u>Ulnar head</u>: coronoid process of ulna	Middle of Lateral surface of Radius.	Median nerve	Pronation

SURGICAL IMPORTANCE: Median n. may be compressed between its 2 heads.

FLEXOR CARPIRADIALIS

Origin	Insertion	N. Supply	Action
Common flexor origin (CFO)	Bases of 2nd & 3rd palmar metacarpals	Median nerve	Flexion of elbow & wrist & radial deviation of wrist

PALMARIS LONGUS

Origin	Insertion	N. Supply	Action
Common flexor origin	Palmar aponeurosis	Median nerve	Flexion of the wrist

SURGICAL IMPORTANCE: Its tendon can be used as a tendon graft.

FLEXOR CARPI ULNARIS MCQ

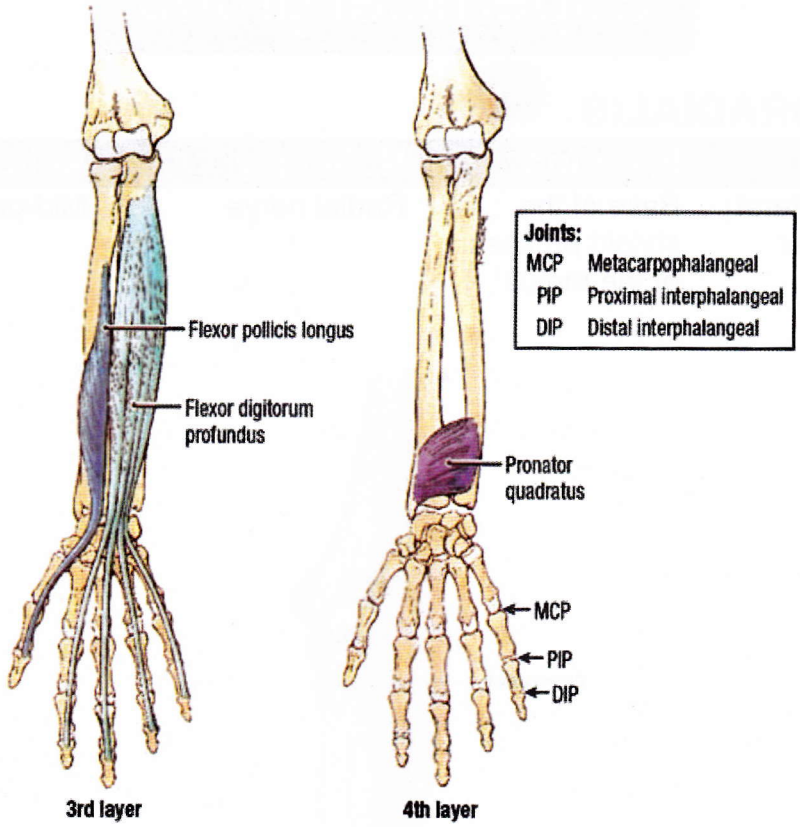
Origin	Insertion	N. Supply	Action
Humeral: common flexor origin. Ulnar : posterior border of the ulna	Pisiform bone (Piso-hamate & piso-metacarpal ligament are continuations of its tendon)	Ulnar nerve	Flexion of the elbow & wrist & ulnar deviation of the wrist

FLEXOR DIGITORUM SUPERFICIALIS MCQ

Origin	Insertion	N. Supply	Action
Humero-ulnar: common flexor origin Radial: anterior oblique line of the radius	4 tendons each split → attached to sides of middle phalanx of medial 4 fingers	Median nerve	- Flexion & ulnar deviation of the wrist - Flexion of proximal IP joint of medial 4 fingers

- It lies in an intermediate plane between superficial & deep flexors
- it gives 4 tendons deep to flexor retinaculum
- Its synovial sheath is common with that of flexor digitorum profundus
- In front of wrist its tendons are arranged in two strata.

Deep group



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Flexor Digitorum Profundus

Origin	Insertion	N. Supply	Action
Upper ¾ of the front of the ulna	Base of the terminal phalanx of the medial 4 fingers	Lat ½: anterior interosseus nerves Med ½: ulnar nerve	Flexion of medial 4 fingers at the DIP joint & flexion of the wrist MCQ

Flexor Pollicis Longus

Origin	Insertion	N. Supply	Action
Upper ⅔ of front of radius	Base of the terminal phalanx of thumb	Anterior interosseus nerve	Flexion of the thumb & flexion of wrist

Pronator Quadratus

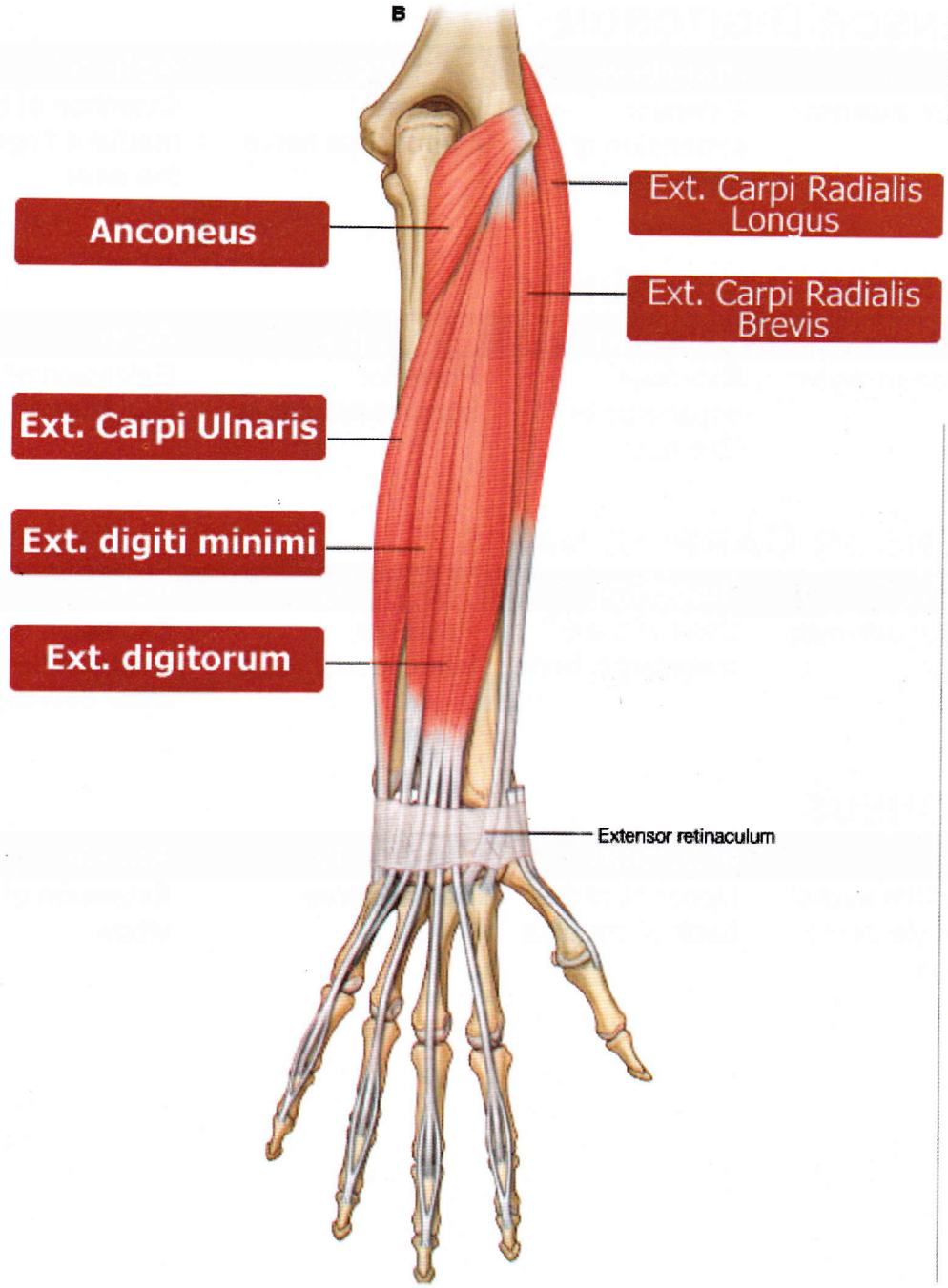
Origin	Insertion	N. Supply	Action
Front of the lower ¼ of ulna	Front of the lower ¼ of radius	Median nerve	Pronation

Muscles of the Back of the forearm

Superficial group

BRACHIORADIALIS MCQ

Origin	Insertion	N. Supply	Action
Upper ⅔ of lateral supra-condylar ridge	Base of the styloid process of the radius	Radial nerve	Mid-prone position



EXTENSOR CARPI RADIALIS LONGUS

Origin	Insertion	N. Supply	Action
Lower ⅓ of lateral supra-condylar ridge	Base of 2nd metacarpal bone (dorsum)	Radial nerve	Extension & radial deviation of the wrist

EXTENSOR CARPI RADIALIS BREVIS

Origin	Insertion	N. Supply	Action
Common extensor origin (front of lateral epicondyle)	Base of the 3rd metacarpal bone (dorsum)	Posterior interosseus nerve	Extension & radial deviation of the wrist

EXTENSOR DIGITORUM

Origin	Insertion	N. Supply	Action
Common extensor origin	Extensor expansion of med 4 fingers	Posterior interosseus nerve	Extention of the medial 4 fingers & the wrist

EXTENSOR DIGITI MINIMI

Origin	Insertion	N. Supply	Action
Common extensor origin	Extensor expansion of little finger	Posterior interosseus nerve	Extension of the little finger

EXTENSOR CARPI ULNARIS

Origin	Insertion	N. Supply	Action
Common extensor origin	Base of the 5th metacarpal bone	Posterior interosseus nerve	Extension of the wrist & elbow & ulnar deviation

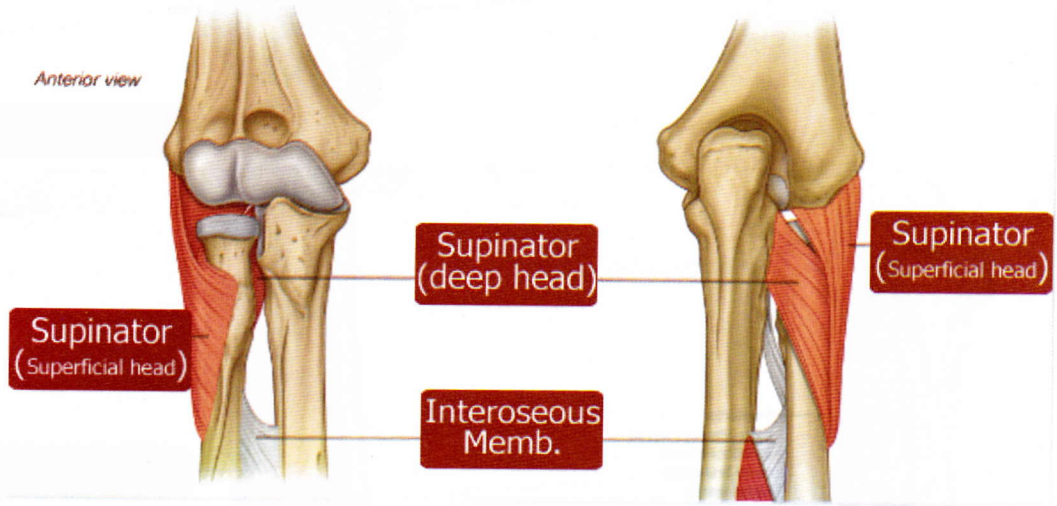
ANCONEUS

Origin	Insertion	N. Supply	Action
Back of the lateral epicondyle of the humerus	Upper ¼ of the back of the ulna	Radial nerve	Extension of the elbow

Deep group

SUPINATOR MCQ

Origin	Insertion	N. Supply	Action
Supinator fossa of the ulna	Posterior surface of the radius	Posterior interosseus nerve	Supination & extension of the elbow



ABDUCTOR POLLICIS LONGUS

Origin	Insertion	N. Supply	Action
Back of the radius, ulna & interosseus membrane	Lateral of base of the 1st metacarpal bone	Posterior interosseus nerve	Abduction of the thumb

EXTENSOR POLLICIS BREVIS

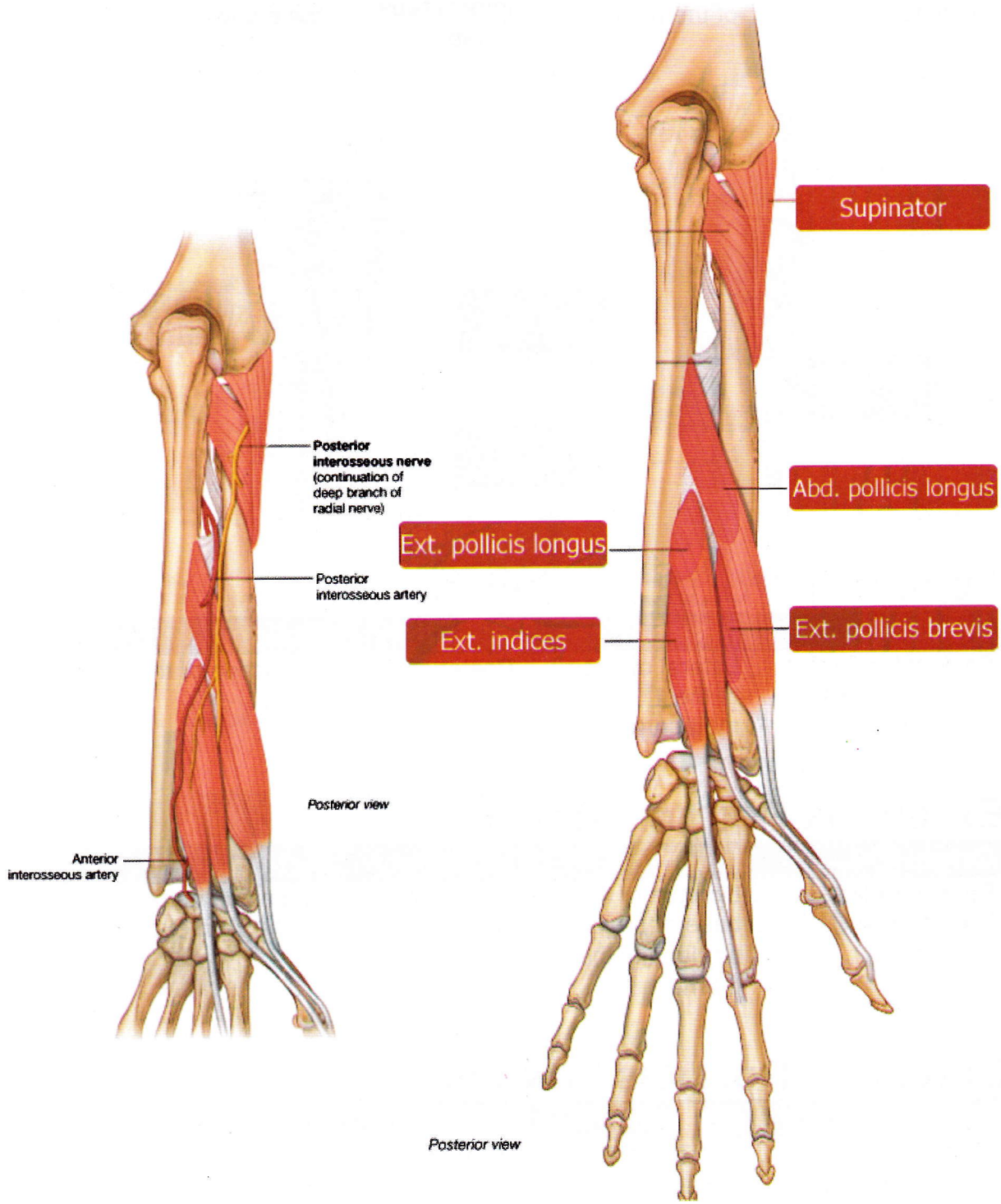
Origin	Insertion	N. Supply	Action
Back of radius & interosseus membrane	Dorsum of the base of proximal phalanx of the thumb	Posterior interosseus nerve	Extension of the thumb at MPJ **(main extensor)** MCQ

EXTENSOR POLLICIS LONGUS

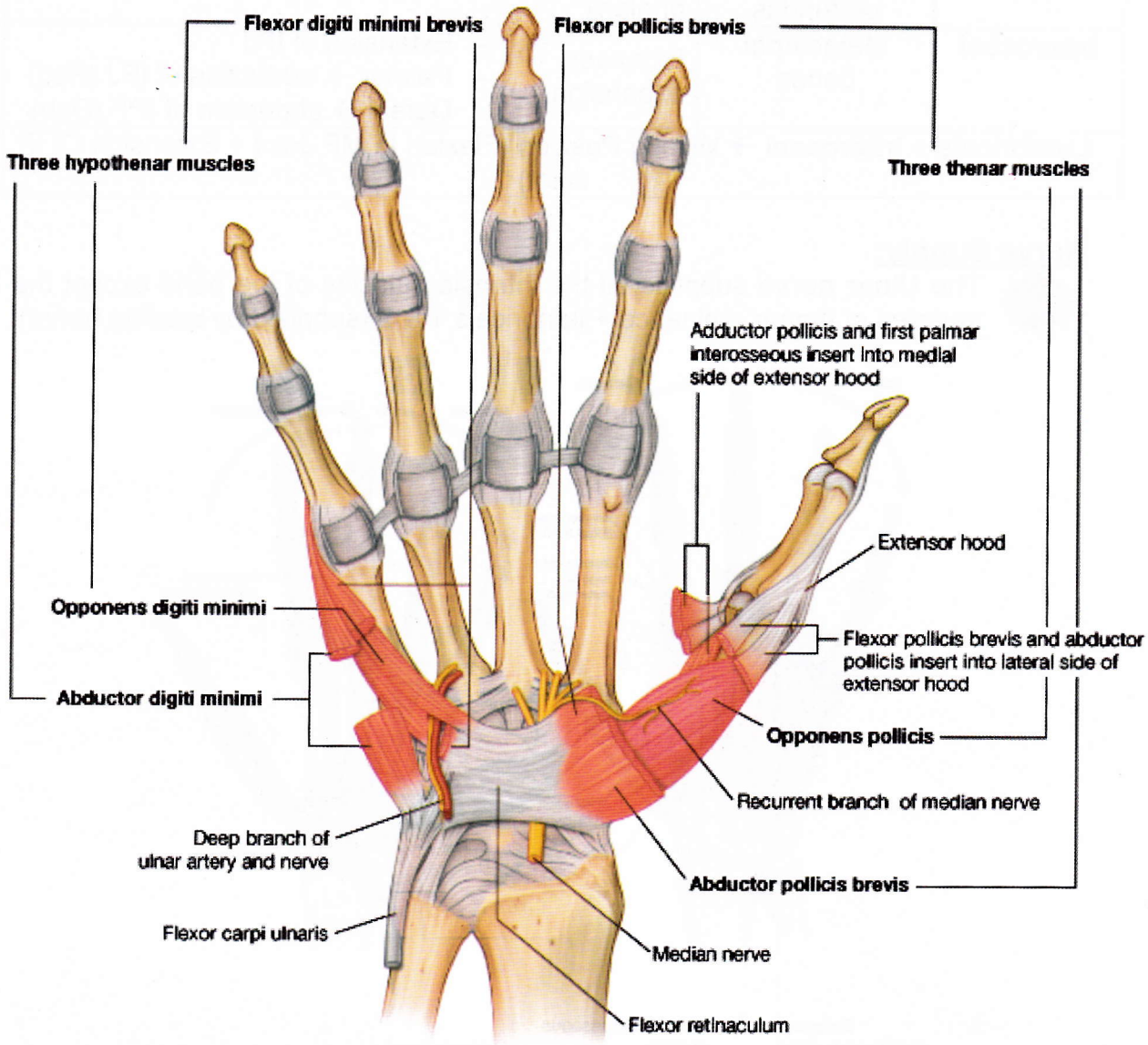
Origin	Insertion	N. Supply	Action
Middle ⅓ of the posterior surface of the ulna & the interosseus membrane	Dorsum of the base of the terminal phalanx of the thumb	Posterior interosseus nerve	Extension of all the joints of the thumb

EXTENSOR INDICIS

Origin	Insertion	N. Supply	Action
Back of the lower part of ulna & interosseus membrane	Extensor expansion of index finger	Posterior interosseus nerve	Extension of the index finger



Muscles of the Hand



These include:

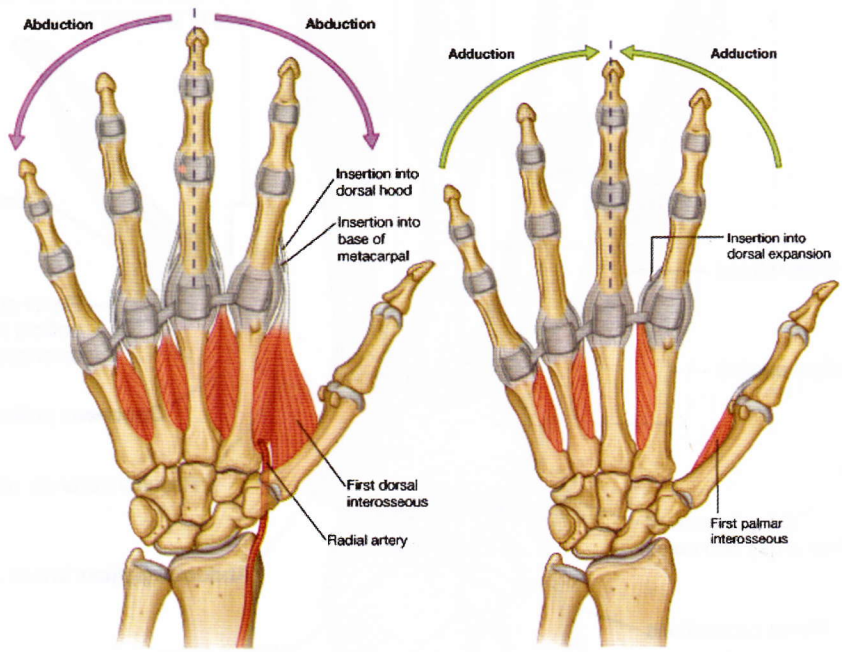
MCQ

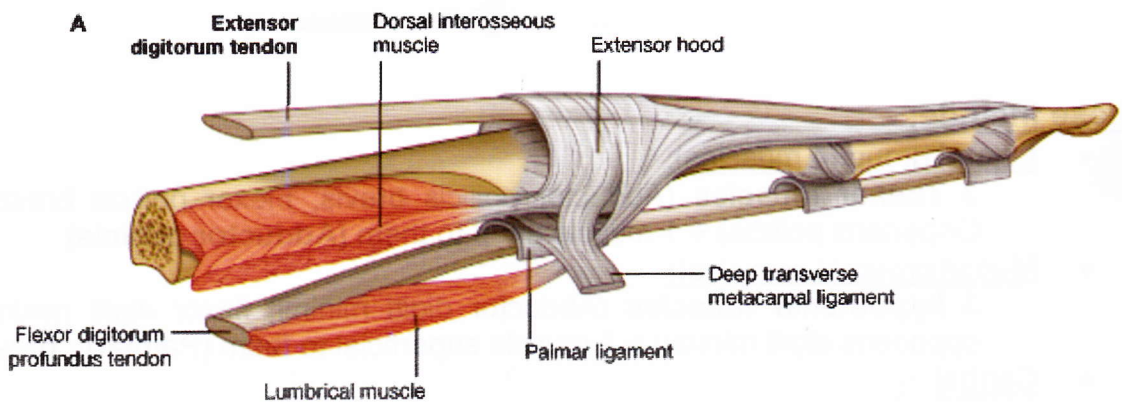
- Lateral group (4 muscles):
  3 Thenar muscles (Abductor pollicis brevis, Flexor pollicis brevis, & Opponens pollicis) **+** 1 muscle deep to them **(Adductor pollicis)**.
- Medial group (4 muscles):
  3 hypothenar muscles (Abductor digiti minimi, flexor digiti minimi & opponens digiti minimi) **+** 1 muscle superficial to them **(Palmaris brevis).**
- Central
  - 4 lumbricals.
  - 4 palmar interossei.
  - 4 dorsal interossei.

Muscle	Origin	Insertion	Action MCQ
Lumbricals	Tendons of flexor digitorum profundus	Base of proximal phalanx	- Flexes MPJ - Extends IPJ
Interossei	Metacarpal bones	Extensor expansion	- Extension of IPJ - Palmar → adduction of IPJ (Pad) - Dorsal → abduction of IPF (Dab)
Lumbricals + Interossei → Writing Position (Flexion In MP Joint + Extension Of IP Joint)			

Nerve Supply:

MCQ **The Ulnar nerve** supplies all the intrinsic muscles of the hand except the 3 muscles of thenar eminence + lumbricals 1 & 2 (supplied by median nerve).





CHAPTER 3

THORAX

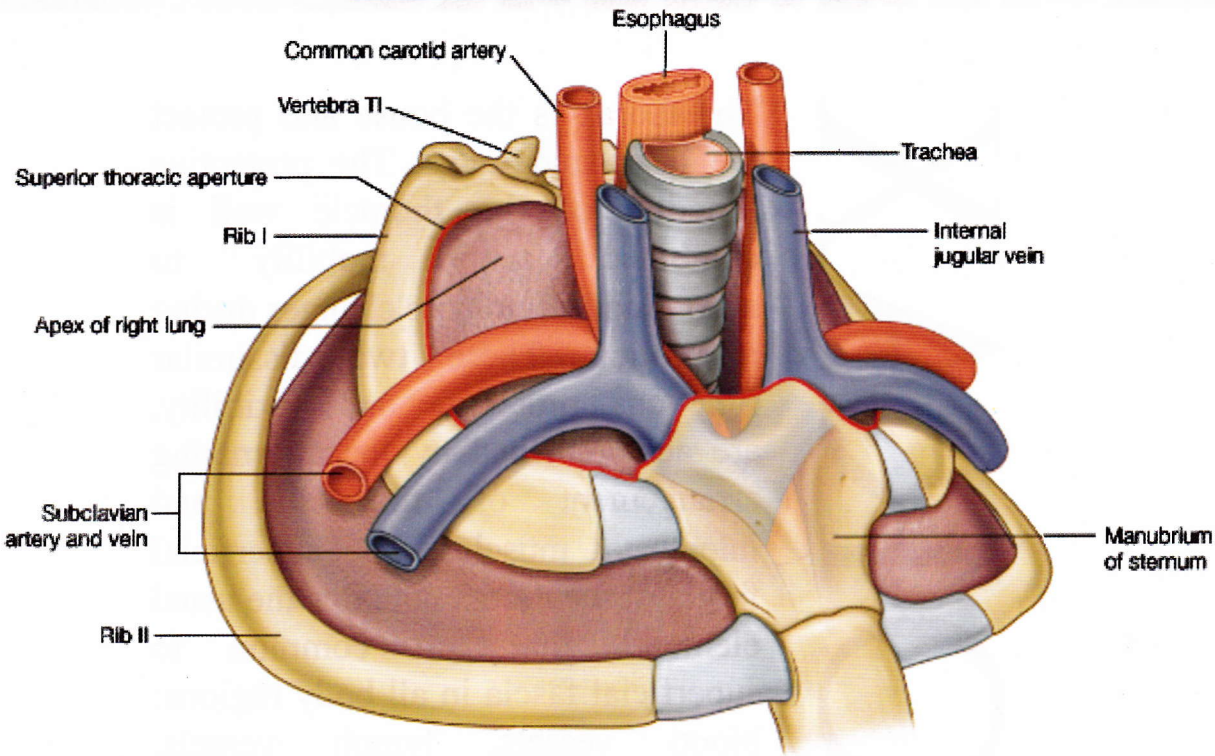
The thorax is the house and protect the heart and lungs. The protective function of the thoracic wall is combined with mobility to accommodate volume changes during respiration. These two dissimilar functions, protection and flexibility, are accomplished by the alternating arrangement of the ribs and intercostal muscles. The superficial fascia of the thorax contains the usual elements that are common to superficial fascia in all body regions: blood vessels, lymph vessels, cutaneous nerves, and sweat glands. In addition, the superficial fascia of the anterior thoracic wall in the female contains the mammary glands.

THORAX

THE 1ST RIB

- Supra-pleural membrane is attached to the inner margin of the 1st rib.
- If a rib is fractured at two nearby places, the part of rib between two fractured sites will show **Paradoxical movement** (Moves inward during inspiration). MCQ

Thoracic Inlet

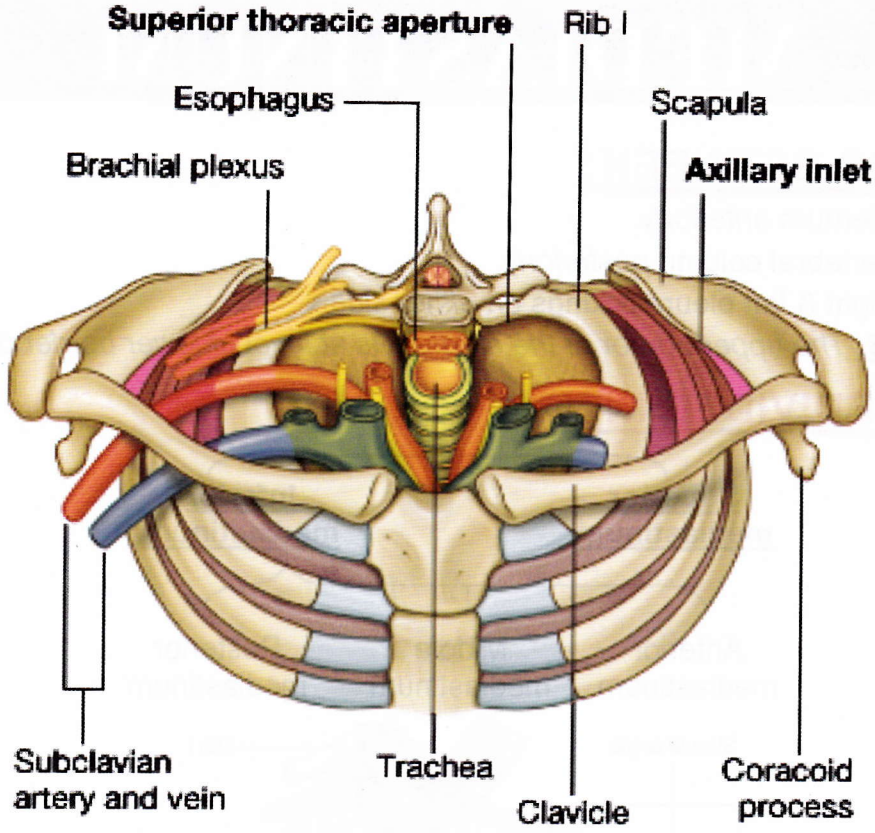


DEFINITION

- The opening at the superior end of the rib cage through which cervical structures enter the thorax.
- It marks the boundary between the neck & the superior mediastinum.
- **Clinically, it is called *thoracic outlet*.**

BOUNDARIES:

- ***Anterior:*** manubrium sterni.
- ***Posterior:*** T1 vertebral body.
- ***On both sides:*** the 1st ribs & their costal cartilages.



CONTENTS:

Structures that pass through the **thoracic inlet:**

- **Tubes:**
  - Trachea.
  - Esophagus.

- **Nerves:**
  - Phrenic nerve.
  - Vagus nerve.
  - Recurrent laryngeal nerves.
  - Sympathetic trunks.

- **vessels**
  - **arteries:**
    - common carotid arteries
    - brachiocephalic trunk
    - subclavian arteries
  - **veins:**
    - internal jugular veins
    - brachiocephalic veins
    - subclavian veins
  - **Lymphatic vessels and lymph nodes.**

SURGICAL IMPORTANCE: Thoracic outlet syndrome

MEDIASTINUM

EXTENDS BETWEEN:

- Sternum *anteriorly*.
- Vertebral column *posteriorly*.
- Right & left pleura & lungs *on either side*.

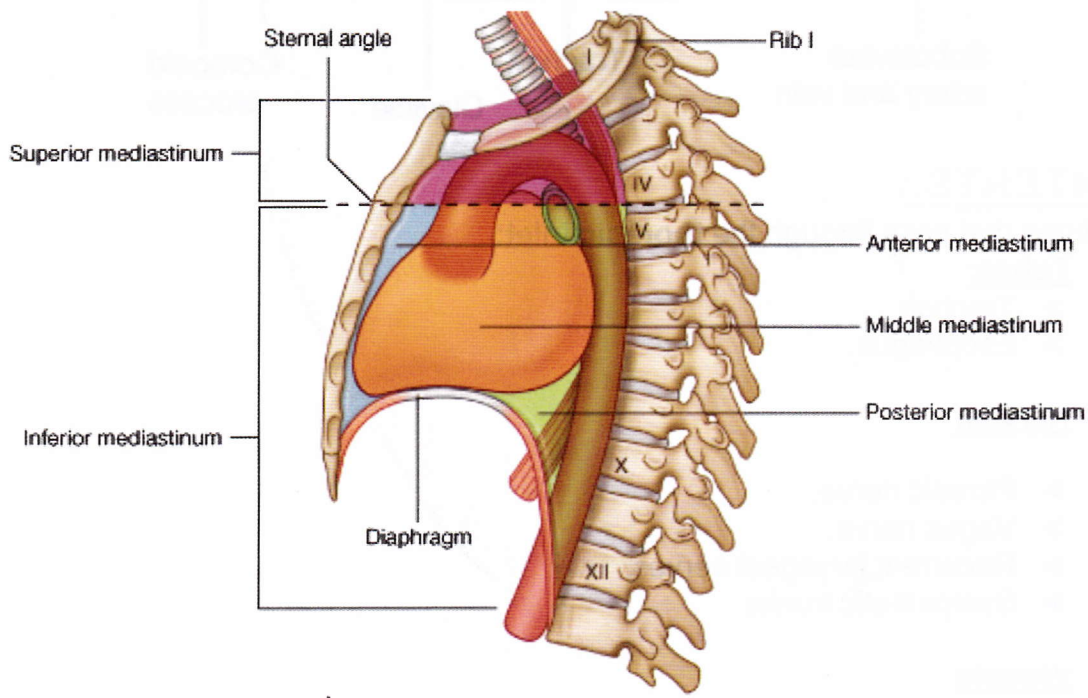
MCQ

N.B: *The upper border of the sternum is at level of lower border of T2)*

IT IS SUBDIVIDED INTO

Superior mediastinum | **Inferior mediastinum**

Anterior mediastinum | Middle mediastinum | Posterior mediastinum



Superior mediastinum

BOUNDARIES

MCQ

- **Anterior:** manubrium sterni.
- **Posterior:** T1 - T4.
- **Below:** line joining the sternal angle to the lower border of T4.
- **Lateral:** pleura.

CONTENTS:

- ***Arteries***: aortic arch, innominate artery, left common carotid & left subclavian.
- ***Veins***: innominate veins & SVC.
- ***Nerves***: the vagus, cardiac, phrenic, and left recurrent nerves.

The trachea is related anteriorly to:

- Isthmus of thyroid gland.
- Inferior thyroid veins.
- Arch of aorta.
- Origin of the left common carotid artery.
- The brachiocephalic trunk ascends at first in front of & then to the right of trachea.

- ***Tubes***: trachea, esophagus and thoracic duct.
- ***Thymus gland & some LNs.***

Anterior mediastinum

CONTENTS:

- Loose areolar tissue.
- Lymph vessels and nodes.
- Fat.
- Thymus gland *(Prominent in children).* MCQ
- Sterno-pericardial ligaments.

Middle mediastinum

CONTENTS:

- The heart & pericardium.
- The ascending aorta.
- The superior vena cava with the azygos vein opening into it.
- The pulmonary artery dividing into its two branches.
- The right & left pulmonary veins.
- The phrenic nerves.
- Some bronchial LNs.
- The bifurcation of the trachea & the two bronchi.

N.B:

MCQ

- The site chosen for pericardiocentesis: **Left 5th intercostals space**.
- Posterior inter-ventricular artery is a branch of right coronary, while anterior inter-ventricular is a branch of left coronary.

Posterior mediastinum

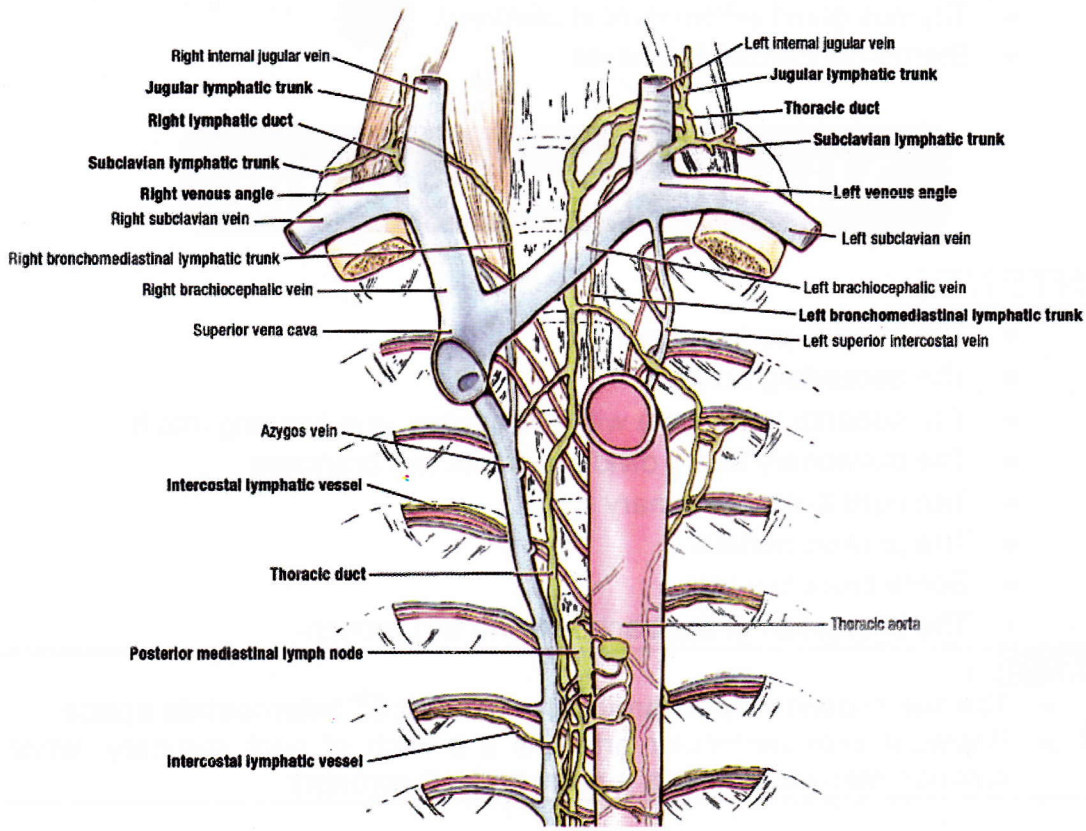
MCQ

CONTENTS:

- ***Arteries***: thoracic part of the descending aorta.
- ***Veins***: azygos & hemi-azygos vein.
- ***Nerves***: vagus & thoracic splanchnic nerves.
- ***Esophagus***.
- ***Lymph structures:*** thoracic duct & some LNs.

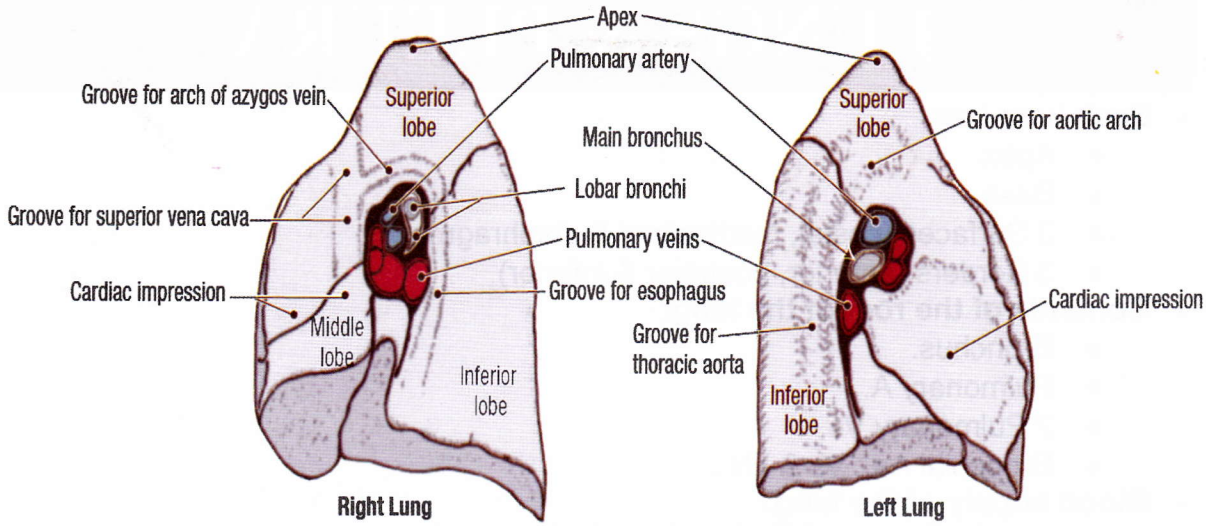
Thoracic duct

- 45 cm long.
- It is the upward continuation of **the cisterna chyli.**
- It enters the thorax through the aortic opening of the diaphragm between the azygos vein medially & aorta laterally.
- **Course:**
  - Ascends behind esophagus in the posterior mediastinum and crosses midline at T5.
  - Lies superficial (anterior) to the posterior intercostal arteries, crossing azygos system, the dome of pleura, Lt. vertebral & Lt. subclavian artery.
  - At the level of C7, it crosses laterally behind the carotid sheath & anterior to the vertebral vessels.
- **It ends at:** the confluence of Lt. subclavian vein & Lt. internal jugular vein.
- **Drains:** the lymph from the entire body except Rt. upper limb, Rt. side of chest & Rt. half of head & neck.



LUNGS & PLEURA

- **Each lung has:**
  - Apex.
  - Base.
  - 3 Surfaces (costal, mediastinal & diaphragmatic).
  - 3 Borders (anterior, postreior & inferior).
- **Contents of the root of the lung:**
  - Bronchus.
  - Pulmonary A.
  - 2 Pulmonary Vs.
  - Bronchial As., Vs & LN
- **Blood supply of the lung:**
  - A. Bronchi, CT of the lung & visceral pleura:
    - Bronchial As → 2 Lt. from descending thoracic aorta & 1Rt. from 3rd posterior intercostal A.
    - Bronchial Vs → Azygous & hemiazygous
  - B. Alveoli:
    - Terminal branches of pulmonary As supply the alveoli with all its needs except oxygen.
    - Trebutaries of pulmonary Vs carrying oxygwnated blood.
- **Surface anatomy of the lung:**
  - Apex: 1 inch above the medial 3rd of the clavicle.
  - Anterior border:
    a. Rt. Lung → extend from the apex to the sternoclavicular joint, sternal angle then vertically to the level of 6th costal cartilage.
    b. Lt. lung → extend from the apex to the sternoclavicular joint, sternal angle then vertically to the level of 4th costal cartilage, deviates to the Lt. & descend again 1 inch lateral to sternal margin down to the 6th costal cartilage.
  - Inferior border:
    - ☞ 6th rib (in the midclavicular plane).
    - ☞ 8th rib (in the midaxillary line).
    - ☞ 10th rib (close to the vertebral column).
- ***<u>The right lung is different from the left lung in that:</u>***
  - It is heavier.
  - It is larger in transverse diameter.
  - It has no cardiac notch.
  - It usually has two fissures.
  - It has 2 bronchi in the hilum.
- **The diaphragmatic pleura is supplied by the:** Lower intercostal nerves & phrenic nerves.



Pleura

- The lung is surrounded by the **pleura**, a serous membrane which folds back upon itself to form a two-layered, membranous structure.
- The thin space between the two pleural layers is known as the **pleural space**. It normally contains a small amount of **pleural fluid**.
- The outer pleura (parietal pleura) is attached to the chest wall. While the inner pleura (visceral pleura) covers the lungs and adjoining structures, i.e. blood vessels, bronchi and nerves.
- The parietal pleura is highly sensitive to pain while the visceral pleura is not, due to its lack of sensory innervation.
- Pleural recesses:
  - There are 2 recesses in which the lung expand in full inspiration, which are: Costomediastinal & costodiaphragmatic
- Surface anatomy: (it differs from that of the lung in):
  - Anterior border descends down to the 7^{th} costal cartilage.
  - Inferior border (8^{th}, 10^{th} & 12^{th} ribs instead of 6^{th},8^{th} & 10^{th} ribs).

Pericardium

- The pericardium is a tough, fibrous, outer coating with discrete attachments to the sternum, great vessels, and diaphragm and an inner membranous coat.
- It is divided into two layers, the first of which is called the parietal layer and the second the visceral layer.
- The pericardium contains approximately ten to fifteen cc's of serous fluid.

BLOOD VESSELS OF THORAX

Thoracic aorta

Ascending aorta:

ORIGIN: at the upper part of the base of the left ventricle, on a level with the lower border of the third costal cartilage.

COURSE: it passes obliquely upward, forward, and to the right, in the direction of the heart's axis, as high as the upper border of the second right costal cartilage.

BRANCHES:

The two coronary arteries which supply the heart.

- The Rt. Coronary A. arises from anterior aortic sinus & it gives 2 branches:
  - Marginal artery.
  - Posterior interventricular A.
- The Lt. coronary A. arises from Lt. posterior aortic sinus & it gives 2 branches:
  - Circumflex A.
  - Anterior interventricular A.

Arch of the aorta:

BEGINS & ENDS at the level of (Angle of Lewis). MCQ

BRANCHES

1- Brachiocephalic trunk (Innominate artery)

- The 1st branch of arch of aorta.
- Divides into right common carotid & right subclavian behind the right sterno-clavicular joint.
- It is crossed by the left brachiocephalic vein.

2- Left common carotid artery.

3- Left subclavian artery.

4- Thyroida ima artery (3%).

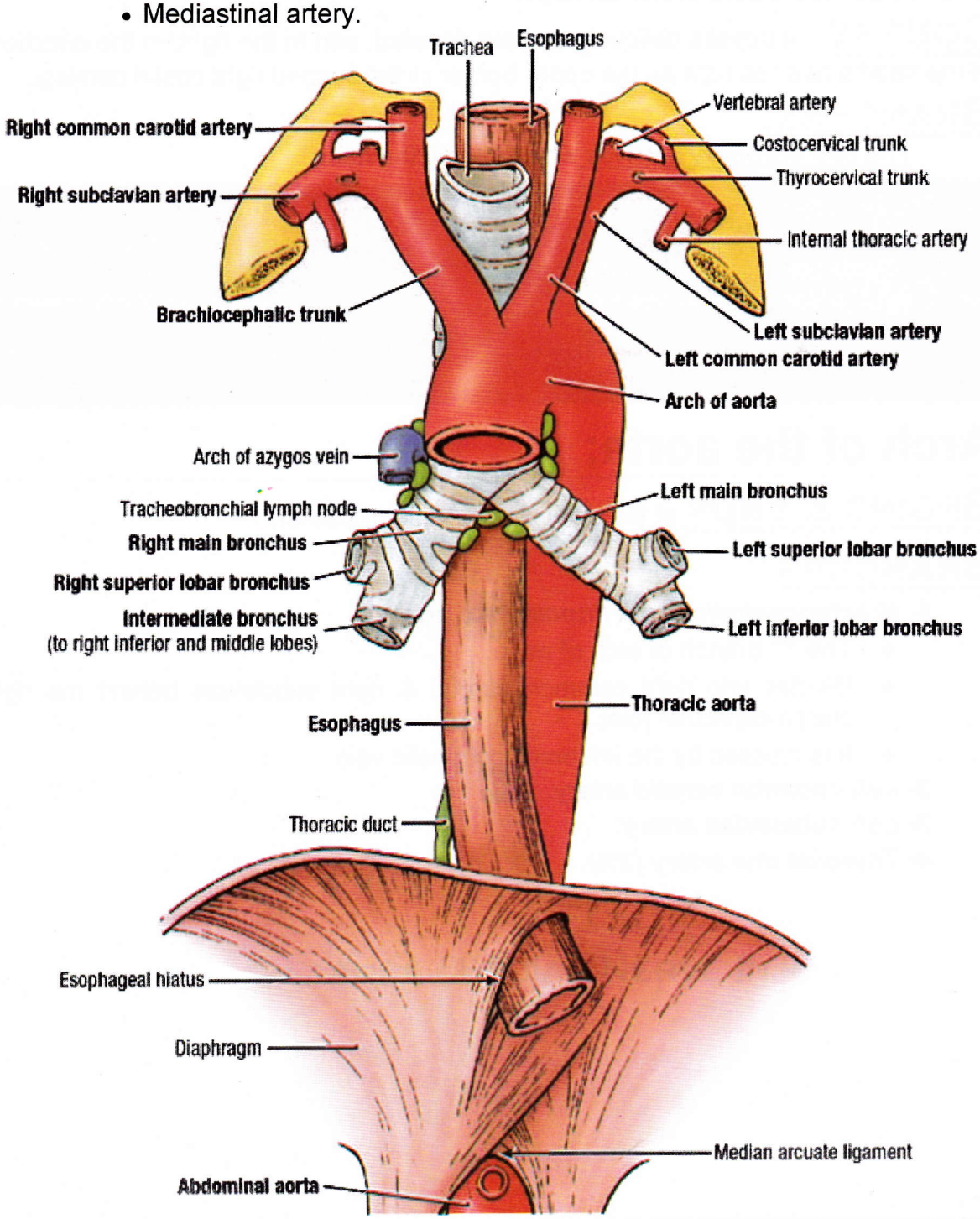
Descending thoracic aorta:

➧ The **thoracic aorta** is one of the contents of the posterior mediastinum

BEGINS & ENDS It begins at the lower border of the 4th thoracic vertebra and ends in front of the lower border of the 10th thoracic vertebra, at the aortic hiatus in the diaphragm where it becomes the abdominal aorta.

BRANCHES

- Bronchial arteries.
- Esophageal arteries.
- Posterior intercostal arteries.
- Sub costal artery.
- Mediastinal artery.



Superior Vena Cava:

BEGIN

The superior vena cava is formed proximally by the union of the right and left brachiocephalic veins within the superior mediastinum. **This occurs at the level of the right first costal cartilage.**

From this point, the SVC runs for about 5-7cm inferiorly, slightly medially and anteriorly.

END

It ends at the superior vena caval orifice in continuity with the right atrium deep to **the third right costal cartilage in the middle mediastinum**. It becomes ensheathed by pericardium superior to this point. Posteriorly, at the level of the second costal cartilage, the ***azygous vein*** arches anteriorly over the root of the right lung to merge with the posterior surface of the SVC.

Brachiocephalic veins

They are valveless veins

BEGINS:

By the union of the internal jugular and the subclavian veins posterior to the medial ends of the clavicle .It receives the internal thoracic vein

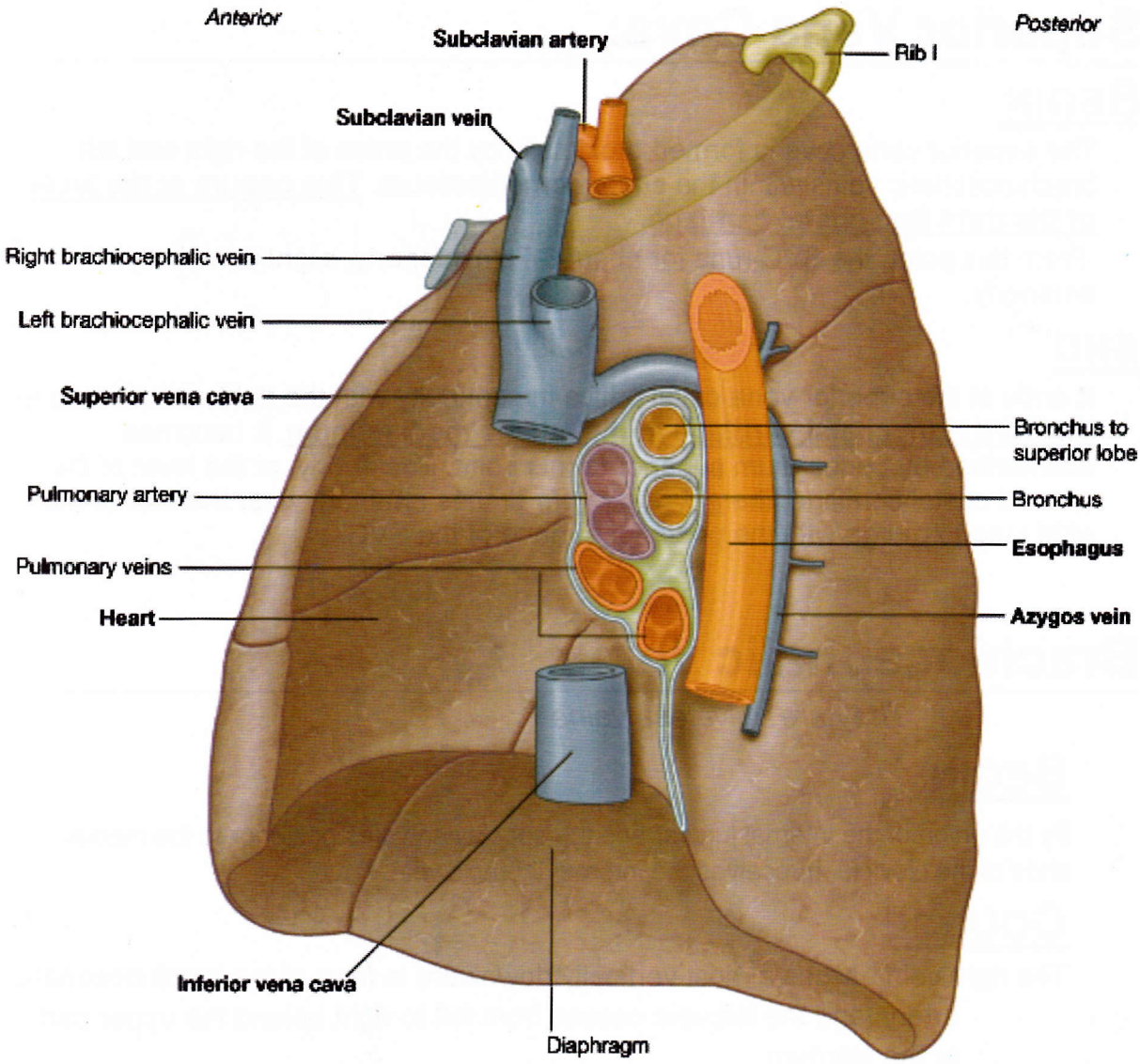
COURSE:

The right vein passes almost vertically downward in front of the brachiocephalic artery, and the left vein passes from left to right behind the upper part of the sternum

ENDS: by the union of Rt & Lt → form the SVC

TRIBUTARIES: Rt→ Rt lymph duct, Lt→ Thoracic duct + as branches of 1st part of subclavian artery

B



The Azygos System of Veins

- The azygos system consists of veins on each side of the vertebral column.
- These veins drain the **back**, **thoracic** and **abdominal walls**.
- The azygos vein and its main tributary, the hemiazygos vein, usually arise from the posterior aspect of the IVC and the **renal vein** respectively.
- These veins provide another means of venous drainage from the abdomen and thorax.

The Azygos Vein

ORIGIN:

- It is formed by the union of the ascending **lumbar veins** with the right **subcostal veins** at the level of the 12th thoracic vertebra,
- The azygos vein connects the **superior and inferior venae cavae**,
- The azygos vein drains blood from the posterior walls of the thorax and abdomen.

COURSE:

- It ascends in the posterior mediastinum, passing close to the **right sides** of the **bodies** of the **inferior eight thoracic vertebrae** (T4-T12).
- It is covered anteriorly by the **oesophagus** as it passes posterior to the **root of the right lung**.
- It then **arches over the superior aspect** of this root to join the SVC.

TRIBUTARIES:

1. Hemiazygos v. is the main tributary.
2. In addition to the **posterior intercostal veins**, the azygos vein communicates with the **vertebral venous plexuses**.
3. This vein also receives the **mediastinal**, **oesophageal**, and **bronchial veins**.

The Hemiazygos Vein:

ORIGIN: It usually begins in the left ascending lumbar vein or renal vein

COURSE:

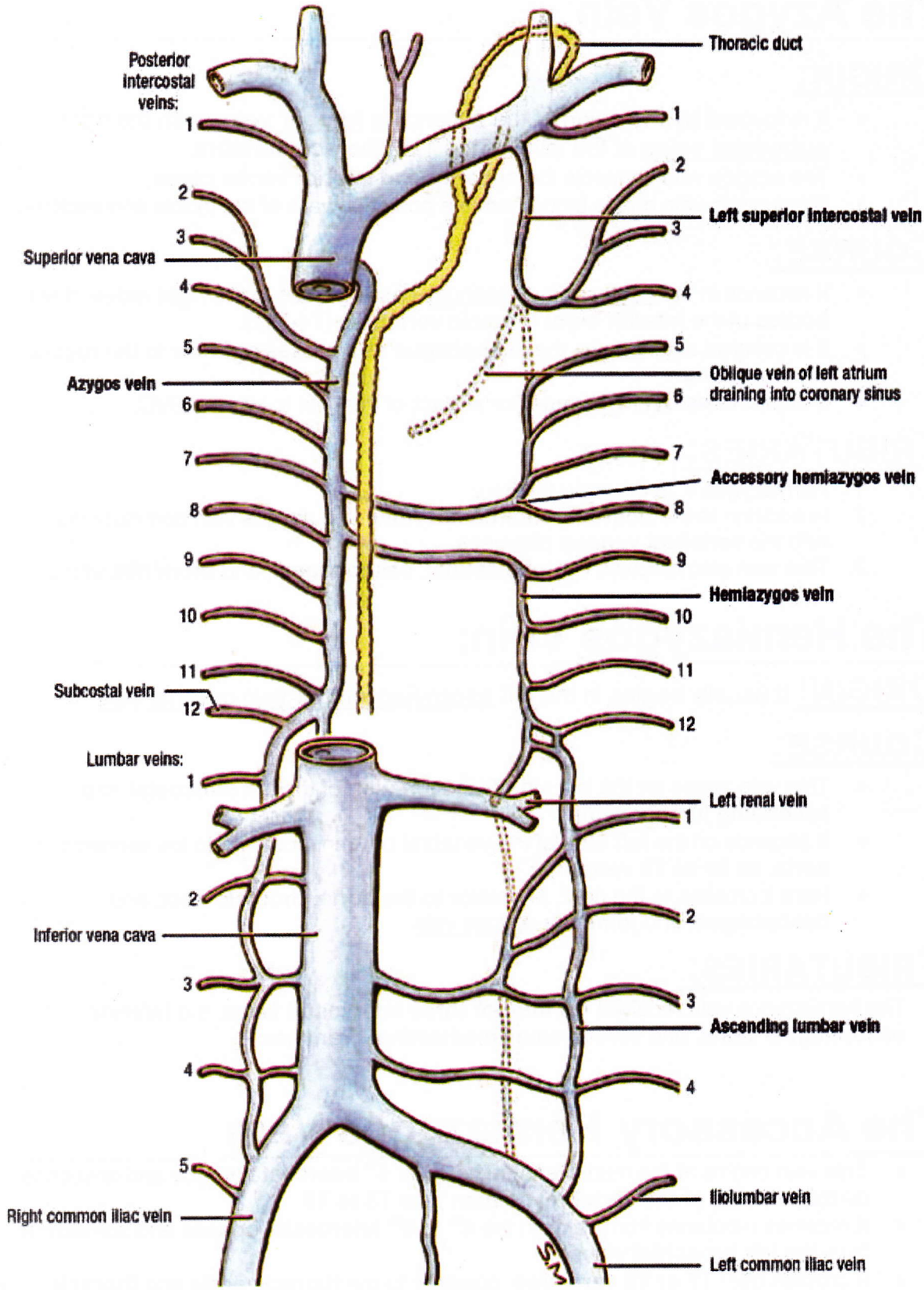
- This vein arises on the **left side** of the **junction** of the **left subcostal and ascending lumbar veins**.
- It ascends on the **left side** of the vertebral column, posterior to the **thoracic aorta**, as far as **T9 vertebra**.
- Here it crosses to the right, **posterior to the aorta**, **thoracic duct**, and **oesophagus**, and **joins the** azygos vein.

TRIBUTARIES:

The hemiazygos vein receives the **inferior three intercostal veins**, the **inferior oesophageal veins**, and several **small mediastinal branches**.

The Accessory Hemiazygos Vein

- This vein begins at the medial end of the **4th** or **5th intercostal space** and descends on the **left side of the vertebral column** from **T5 to T8**.
- It receives tributaries from veins in the **4th to 8th intercostal spaces** and sometimes from the **left bronchial veins**.
- It crosses over **T7 or T8 vertebrae**, posterior to the **thoracic aorta** and **thoracic duct**, where it **joins the azygos vein**.
- Sometimes the accessory hemiazygos vein joins the hemiazygos vein and opens with it in the azygos.
- The accessory azygos vein is frequently connected to the **superior intercostal vein**.


Thoracic duct
Posterior intercostal veins:
1
2
3
4
5
6
7
8
9
10
11
12
Left superior intercostal vein
Superior vena cava
Azygos vein
Oblique vein of left atrium draining into coronary sinus
Accessory hemiazygos vein
Hemiazygos vein
Subcostal vein
Lumbar veins:
Left renal vein
Inferior vena cava
Ascending lumbar vein
Iliolumbar vein
Right common iliac vein
Left common iliac vein

CHAPTER 4

ABDOMEN

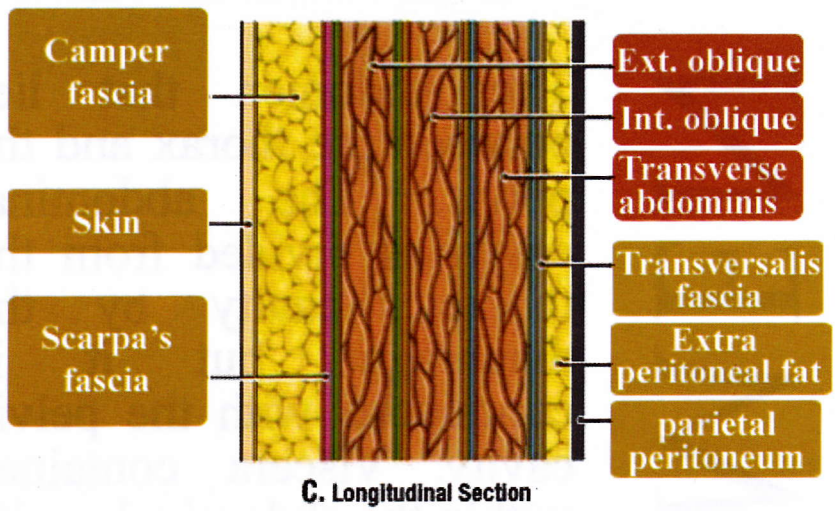
The Abdomen that lies between the thorax and the pelvis. The abdominal cavity is divided from the thoracic cavity by the diaphragm but it is continuous with the pelvic cavity. Viscera contained within the abdominal cavity are not bilaterally symmetrical. Therefore, it is worth noting that use of the words "right" and "left" in names and instructions refers to the right and left sides of the cadaver in the anatomical position.

Abdomen

ANTERIOR ABDOMINAL WALL

Layers of Anterior Abdominal Wall:

(From superficial to deep)



C. Longitudinal Section

- **Lateral:**

1. **Skin.**
2. **Fascia:**
   a. Camper's fascia - fatty superficial layer.
   b. Scarpa's fascia - deep fibrous layer.
3. **Muscles:**
   a. External oblique muscle.
   b. Internal oblique muscle.
   c. Transversus Abdominis muscle.
4. **Fascia transversalis.**
5. **Peritoneum.**

- **Medial:**

1. Skin.
2. Superficial fascia.
3. Anterior wall of rectus sheath.
4. Rectus Abdominis muscle.
5. Posterior wall of rectus sheath.
6. Peritoneum.

FASCIA

There is no deep fascia in the anterior abdominal wall to allow free movement in respiration & distention after meals.

Superficial fascia in the lower part of anterior abdominal wall is differentiated into 2 layers:

A- Superficial Fatty Layer (Camper's Fascia):

1) It corresponds to and is continuous with the subcutaneous fat of the body.
2) Loses its fat in the penis and perineum.
3) **Extent:**
   - Descends to the thigh with its corresponding layer (SC fat).
   - Reflects backwards as the superficial layer of perineum.
4) **In the male,** it is continuous over the penis and becomes dartos fascia in the scrotum.
5) **In the female,** it is continuous from the abdomen to the labia majora.

B- Deep Membranous Layer (Scarpa's Fascia):

1) It is condensation of the superficial fascia; midway between the umbilicus and symphysis pubis.
2) Attachments:
   a- ***Superior:*** it fades away midway between the pubis & umbilicus above & in the lumbar re*gion at the sides.*
   b- ***Inferior:*** *just* below the external ring, the name changes to Colle's fascia.
   c- ***Lateral:*** it is attached to the fascia lata just below (2 fingers' breadth) the inguinal ligament at the groin crease.

MCQ

Because of this attachment to the fascia lata, fluid tracking down from above under the superficial fascia cannot extend further into the thigh below this line of attachment.

Superficial Perineal Fascia (Colle's Fascia)

- It is the continuation of Scarpa's fascia below superficial inguinal ring.
- Extends over:
  - The penis and scrotum; giving a fascial covering.
  - The muscles in the superficial part of the perineum.

MUSCLES OF ANTERIOR ABDOMINAL WALL

1- External oblique muscle.
2- Internal oblique muscle.
3- Transversus abdominis muscle.
4- Rectus abdominis muscle.
5- Pyramidalis muscle.
6- Cremasteric muscle.

1- External oblique muscle:

Origin: fleshy digitations from the lower 8 ribs.

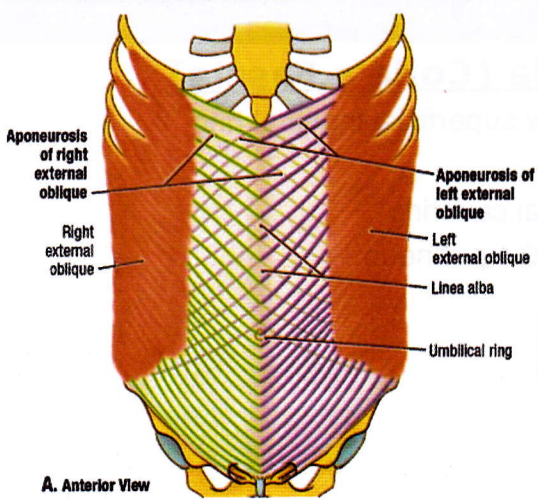
The upper 5 slips interdigitate with the serratus anterior MCQ

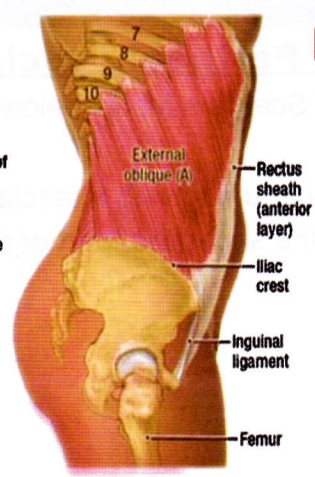
Insertion: fleshy fibers as well as aponeurosis, as follows:

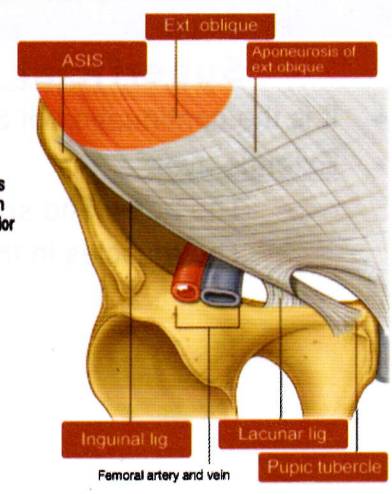
- **Fleshy fibers:**
  - Inserted in the outer lip of the iliac crest.
  - Forms the anterior boundary of the inferior lumbar triangle.
- **Aponeurosis:**
  - Medial part: inserted into linea alba from xiphoid process to symphysis pubis.
  - Lateral part: folded upwards & backwards upon itself to form the inguinal ligament (ASIS → pubic tubercle).

Direction of fibers: Downwards, forwards & medially.

Nerve Supply: Intercostal nerves (T7-T11) & subcostal nerve (T12).

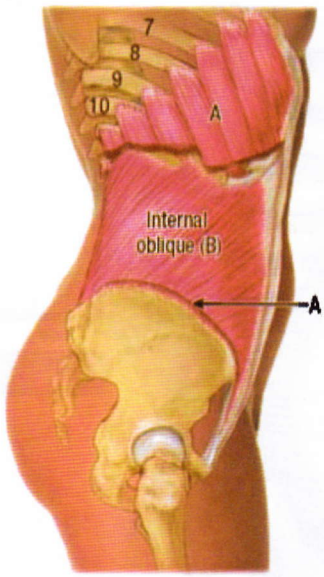




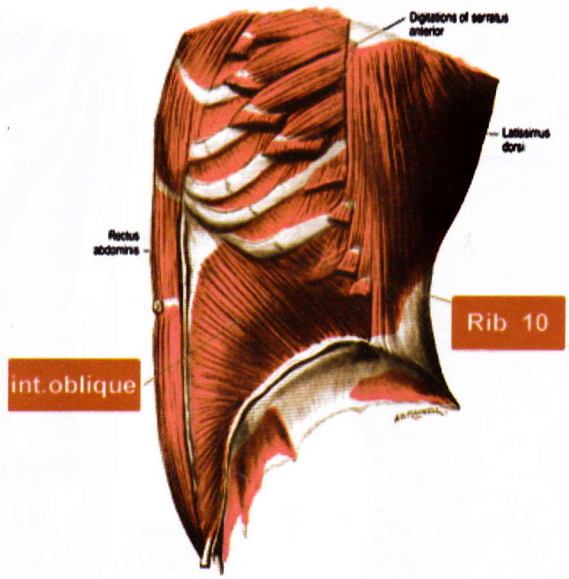


2- Internal Oblique Muscle:

MCQ



A = External oblique ms.



Origin:

1. Lateral ⅔ of the upper surface of inguinal ligament.
2. Anterior ⅔ of the intermediate line of iliac crest.
3. Lumbar fascia.

Insertion:

1) Lower 6 costal cartilages.
2) Xiphoid process.
3) Linea Alba.
4) Pubic crest.
5) Pectineal line.

Direction of fibers:

Upwards, forwards and medially.

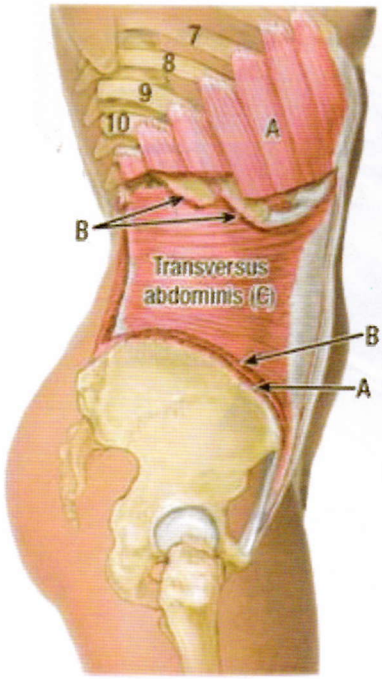
Nerve Supply: MCQ

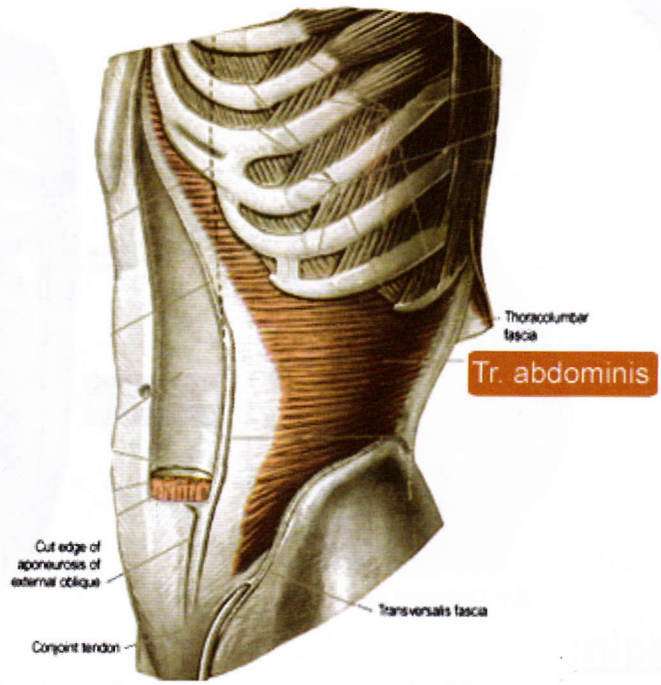
T7 - T12, ilio-hypogastric & ilio-inguinal nerves (L1).

MCQ

- Internal oblique shares in forming anterior & posterior rectus sheaths.
- It has triple relation to the inguinal canal (anterior, superior & posterior).

3- Transversus Abdominis Muscle:





A = External oblique ms.
B = Internal oblique ms.

Origin:

a. Lower 6 costal cartilages.
b. Lumbar fascia.
c. Anterior ⅔ of inner lip of iliac crest.
d. Lateral ⅓ of the upper surface of inguinal ligament.

Insertion:

1- Xiphoid process.
2- Linea Alba.
3- Pubic crest.
4- Pectineal line.

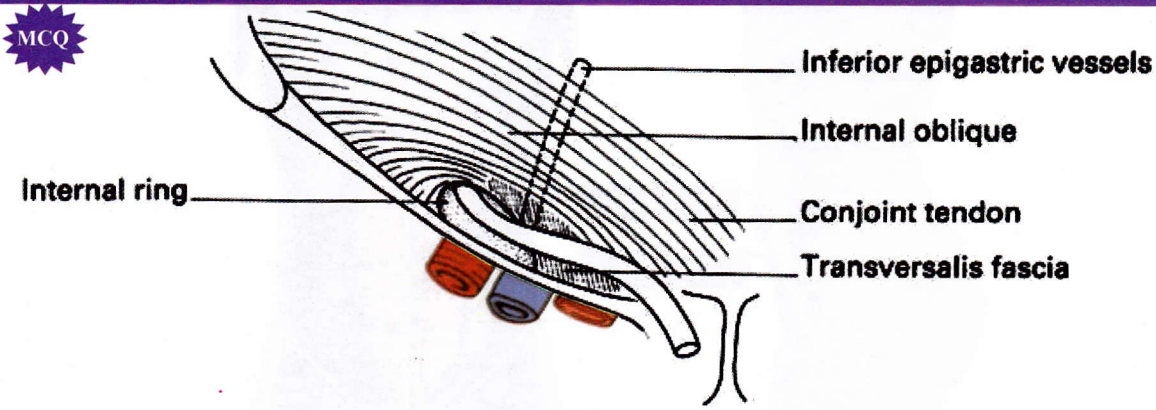
Direction of fibers: Horizontally (transversally forward).

Nerve Supply:

T7 - T12, ilio-hypogastric & ilio-inguinal nerves (L1).

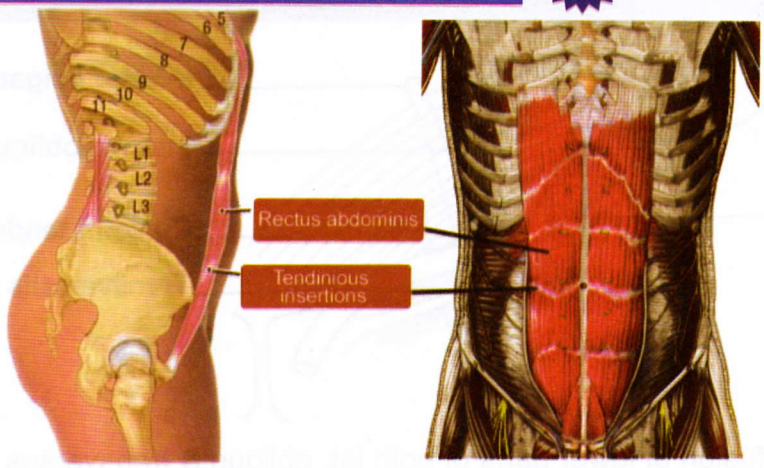
Conjoint Tendon

MCQ



- Formed by fusion of lower parts of both int. oblique & transversus abdominis.
- It is inserted in pubic crest & Ilio-pectineal eminence.
- It forms & strengthens the medial part of the posterior wall of inguinal canal.
- It is continuous medially with the anterior wall of rectus sheath.
- *Nerve supply:* ilio-inguinal nerve.
- *Surgical importance:*
  i) Its weakness predisposes to direct inguinal hernia.
  ii) Injury of ilioinguinal n. during appendicectomy → paralysis of conjoint tendon → direct inguinal hernia (paralytic type).
  iii) Conjoint tendon prevents direct inguinal hernia from descending to scrotum. So, its defect → descent of direct inguinal hernia to the scrotum (funicular type).

4- Rectus Abdominis Muscle MCQ



Origin:

From the pubic crest and the symphysis pubis.

Insertion:

i) Xiphoid process.

ii) 5th, 6th, and 7th costal cartilages.

Nerve supply:

Lower 5 intercostals (T7 - T11) and subcostal nerve (T12).

Surgical importance:

- **In Kocher incision,** rectus abdominis must be divided.
- **In para-median incision,** we displace the muscle laterally as it receives its nerve supply from the lateral side.
- **Embryologically, the muscle arises from a number of myotomes, So:**
  - The muscle has a segmental nerve supply (myotomes).
  - It is divided into 4 segments by 3 tendinous intersections which are adherent to the anterior rectus sheath.
  - Hematoma of rectus abdominis is localized because of the tendinous intersections.

Actions of Anterior Abdominal Wall Muscles

- They assist in raising the intra-abdominal pressure (so, they help in vomiting, coughing, delivery...etc.).
- Keep the abdominal viscera in position.
- The **Rectus abdominis** flexes the trunk, while the 2 oblique muscles bend the trunk laterally.
- Act as accessory expiratory muscles.

5- Pyramidalis Muscle

- It medial border gives linea alba, which is important in lower midline and para-median incisions.

6- Cremasteric Muscle

- It is innervated by genital branch of genito-femoral nerve.

Fascia Transversalis

- This is a thin fascia, which lines the inner surface of the transversus abdominis muscle.
- Forms the posterior wall of rectus sheath below the arcuate line (a little above pubic tubercle)
- Extends as the anterior wall of femoral sheath.
- Prolonged as internal spermatic fascia

Deep inguinal ring:

A small opening in the fascia transversalis. It lies about ½ inch above the mid point of inguinal ligament.

Extra-peritoneal Fat

This is layer of areolar fatty tissue, which lies between the fascia transversalis and the parietal peritoneum.

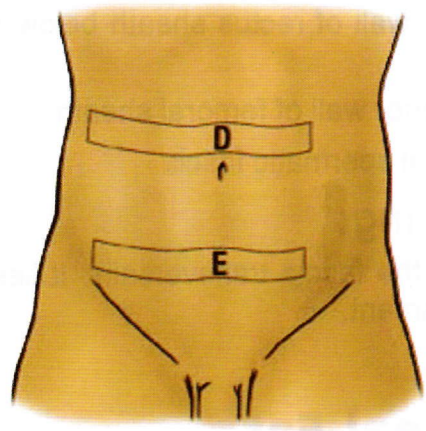
RECTUS SHEATH

Definition: It is envelope-like sheath for rectus muscle.

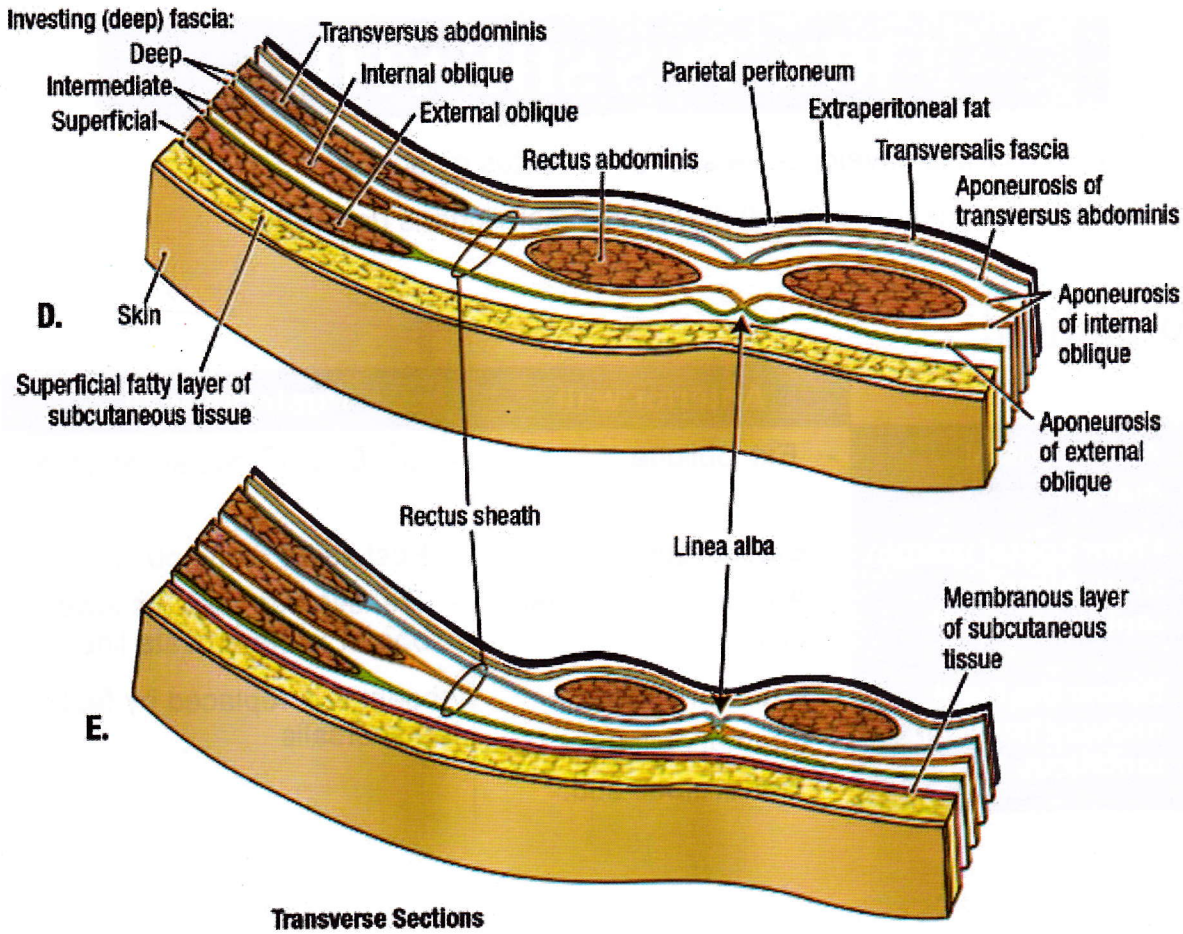
Site: between linea alba **(medially)** & linea semilunaris **(laterally)**.

Formation:

	Anterior wall	Posterior wall
• Above costal margin	- Ext. oblique	- 5th, 6th,& 7th costal cartilages
• From costal margin to midway bet. umbilicus & SP	- Ext. oblique. - Ant. layer of internal oblique.	- Post. layer of int. oblique - Transversus abd. (its lower border is the arcuate line)
• Below the level midway between umbilicus & SP	- External oblique. - Internal oblique. - Transversus abd.	Absent & is replaced by fascia transversalis



Anterior View Showing Location of Section D - E



Transverse Sections

Content MCQ

2 muscles	4 vessels	6 nerves
- Rectus abdominis - Pyramidalis	- Sup. Epigastric vessels - Inf. Epigastric vessels	- Lower 5 intercostal nerves (T7-T11) - Subcostal nerve (T12)

N.B. MCQ

Linea Alba:

- It is a white line in the midline of the abdomen.
- Formed by decussation of the aponeurosis of ext oblique, internal oblique & transversus abdominis muscles.
- Extends from xiphoid process to symphysis pubis (it is not attached to pubic tubercle)
- It is avascular.
- It is broad in its supra-umbilical part (surgical importance: epigastric hernia).

Linea semilunaris:

It is the lateral border of rectus sheath extending from the pubic tubercle below to the tip of the 9th costal cartilage above.

Arcuate line:

A crescentic line that is situated between upper ¾ & lower ¼ of post. wall of rectus sheath.

Sup. & Inf. epigastric arteries **anastomose in the posterior wall of rectus sheath above the level of the umbilicus**

NB:

- ***Fascia lata*** causes arching of the inguinal ligament downwards.
  Application: You must bend the legs during abdominal examination to relax the fascia lata & therefore relax the abdominal muscles.
- ***Fascia iliaca:***
  - It is the continuation of the fascia transversalis posteriorly below the iliac crest over the iliacus muscle.
  - It descends forming the posterior wall of femoral sheath behind the femoral vessels
- Any intra-abdominal organ may herniate except pancreas because it is guarded posteriorly by aorta, IVC & vertebrae.

Arterial supply of anterior abdominal wall: MCQ

1) *Internal Mammary artery:* (through 2 terminal branches)

- Superior epigastric artery.
- Musculo-phrenic artery.

2) *External Iliac artery:* (through 2 terminal branches)

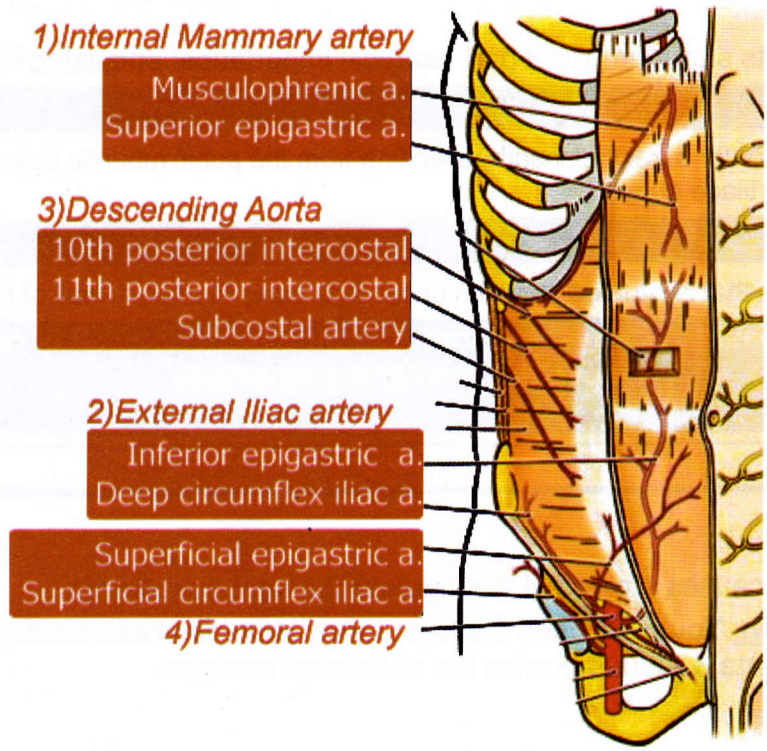
- Inferior epigastric artery.
- Deep circumflex iliac artery.

3) *Descending Aorta:*

- 10th & 11th posterior intercostal arteries.
- Subcostal artery.
- All 4 lumbar arteries.

4) *Femoral artery:*

- Superficial epigastric artery.
- Superficial circumflex iliac artery.

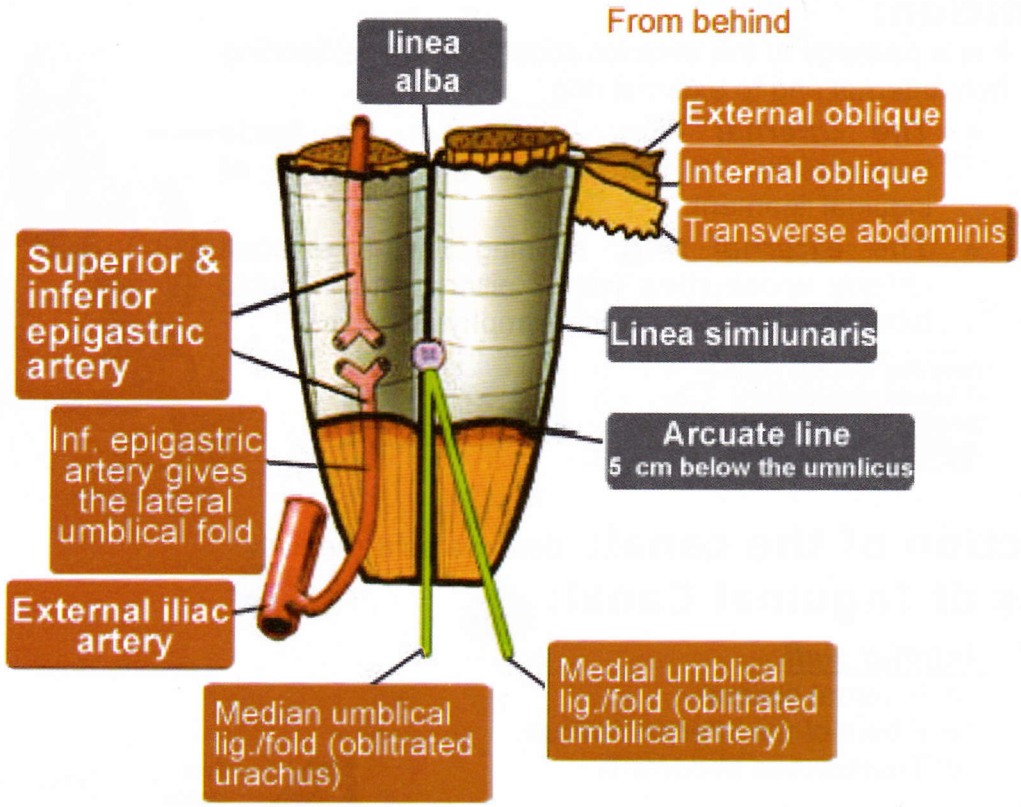


Lymphatic drainage: MCQ

- Above umbilicus → axillary LNs.
- Below umbilicus → Inguinal LNs.

- *The neuro-vascular plane of anterior abdominal wall lies between internal oblique & transversus abdominis muscles.*
- *Lateral thoracic vein anastomoses with superficial epigastric vein.*
- *Skin around the umbilicus is supplied by T10.*

Posterior rectus sheath & umbilical folds



N.B.
There are three folds but only two ligaments. The inferior epigastric artery raises a fold of peritoneum but it is not a ligament!

Umbilical folds

- One **median umbilical fold:** on the median umbilical ligament (which in turn, contains ***the urachus***).
- Two **medial umbilical folds** on the occluded ***umbilical artery.***
- Two **lateral umbilical folds** on ***the inferior epigastric vessels.***

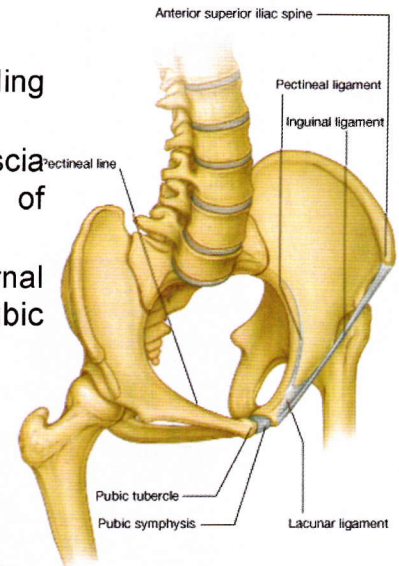
Inguinal Canal (Deep Inguinal Pouch)

Definition:

MCQ

It is a passage in the anterior abdominal wall extending from internal ring to external ring.

- ***The internal ring:*** opening in the fascia transversalis ½ inch above the midpoint of inguinal ligament.
- ***The external ring:*** opening in the external oblique aponeurosis with 2 pillars; one in pubic tubercle & the other in the symphysis pubis.

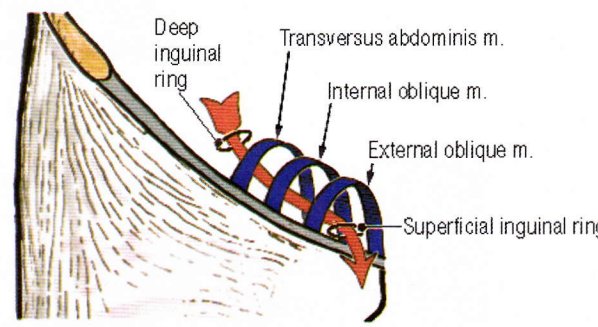


Direction of the canal: downwards & medially.

Walls of Inguinal Canal:

MCQ MCQ

1. ***Anterior wall***
   a. External oblique.
   b. Fibers of the internal oblique.
   c. Transversus abdominis.
2. ***Posterior wall***
   a. Fascia transversalis.
   b. Conjoint tendon (in its medial ½ only).
3. ***Roof***
   a. Arching fibers of the internal oblique.
   b. Transversus abdominis muscle.
4. ***Floor***
   Inguinal ligament (its medial ½).



Length: 4 cm in adults.

MCQ

N.B: In infants, superficial & deep rings are superimposed → shorter canal than that in adults.

Contents:

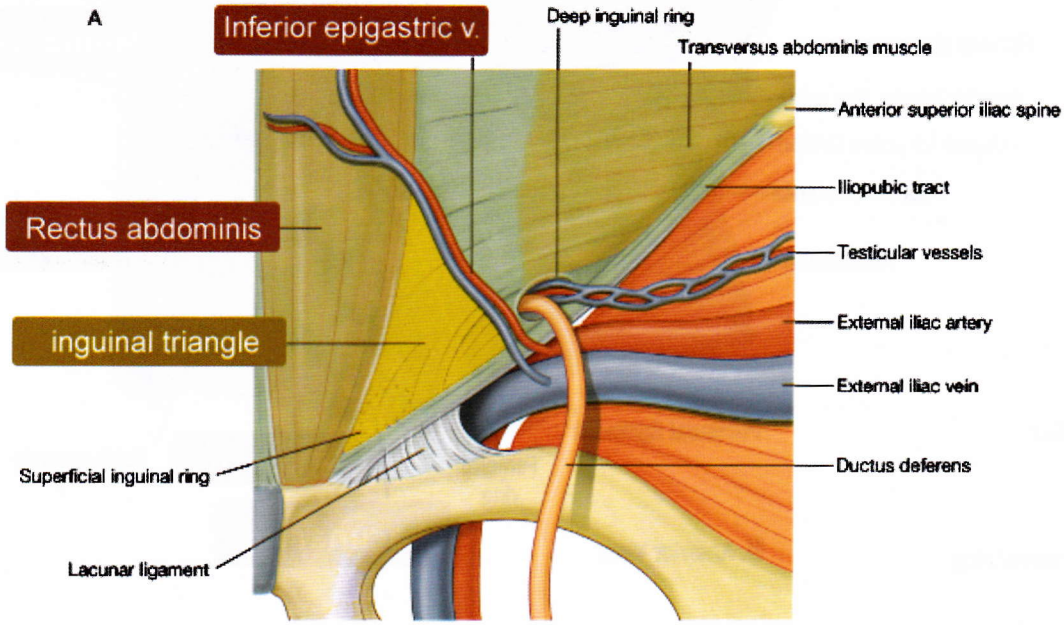
MCQ

Male	Female
- Spermatic cord - Ilio-inguinal nerve	- Round ligament - Ilio-inguinal nerve

Triangle of Halshted (Hasselbach's or Inguinal Triangle)

MCQ

- It is a part of the posterior wall of the inguinal canal.
- **It is bounded by:**
  - ***Laterally:*** Inferior epigastric vessels.
  - ***Medially:*** Lateral border of rectus sheath.



  - ***Inferior:*** Inguinal ligament (only medial ½).
- It is divided by the lateral umbilical ligament into medial and lateral parts.

Surgical Importance:

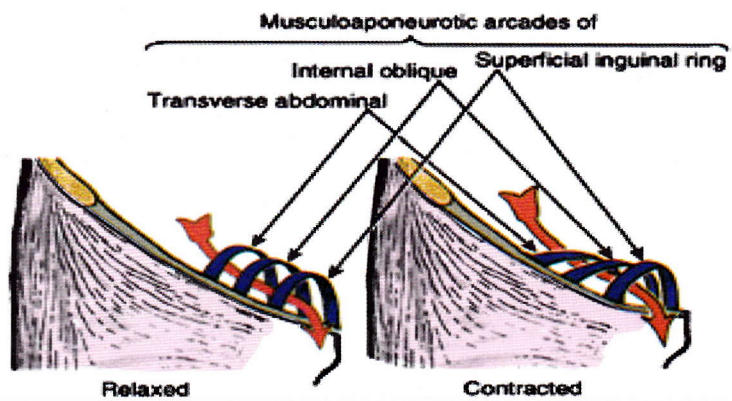
It is the triangle through which direct inguinal hernia passes.

N.B: Direct inguinal hernia is more common in old age.

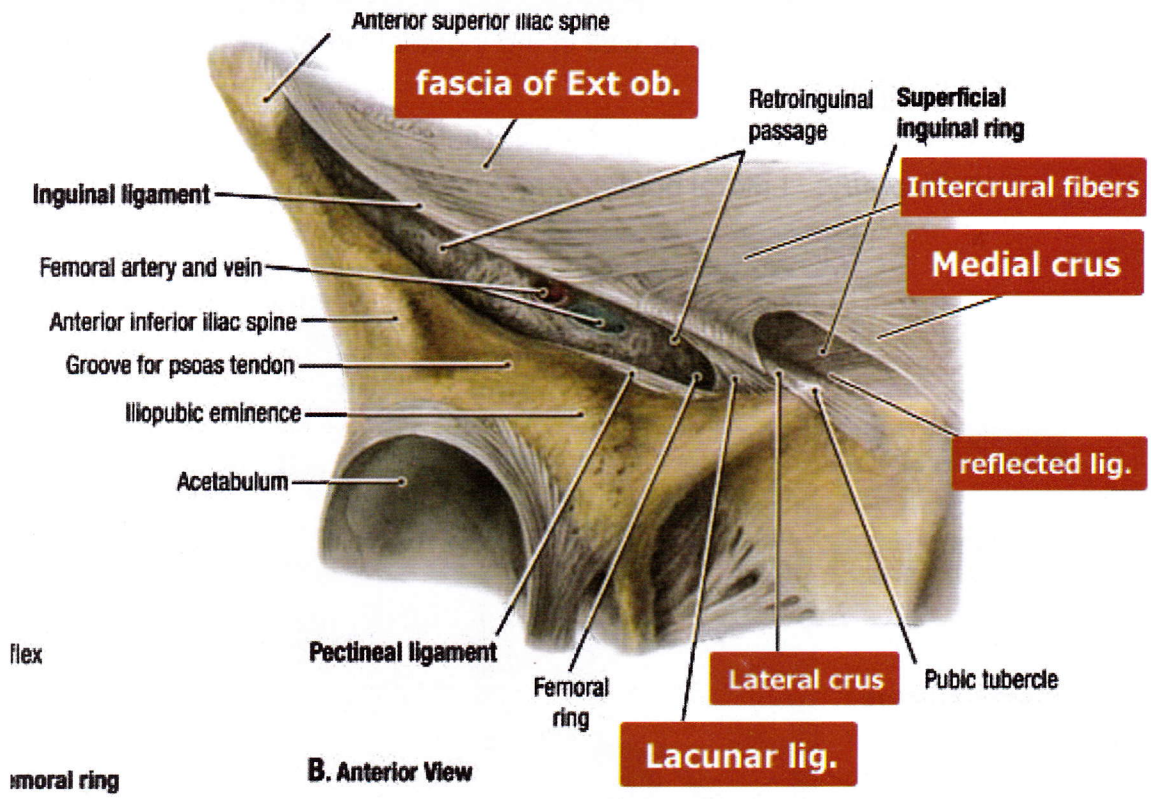
Normally, 2 mechanisms act to prevent herniation through the inguinal canal while increasing intra-abdominal pressure:

i) ***Shuttering mechanism*** in which contraction of the arching fibers of the transversus abdominis cover a part of the internal ring with cough.

ii) The attachment of the deep inguinal ring to the posterior surface of the transversus muscle. So, the contraction of the muscle pulls the ring upwards & laterally thus ***increasing the obliquity*** of the canal.



Inguinal ligament



The inguinal ligament

- Formed by the lower border of ext. oblique aponeurosis between pubic tubercle & A.S.I.S. being folded backward upon itself.
- Its convex outer surface is attached to the fascia lata (deep fascia of the thigh).

Mid inguinal point

Point mid way between A.S.I.S. & symphysis pubis. It is the surface anatomy of the external iliac artery.

Mid-point of inguinal ligament

Point mid way between A.S.I.S. & pubic tubercle. Half an inch above it, is the internal ring.

Lumbar Triangles

Superior Lumbar Triangle

Boundaries:

- **Superior:** last rib.
- **Lateral:** internal oblique & latissimus dorsi.
- **Medial:** sacrospinalis & quadratus lumborum.

Inferior Lumbar Triangle

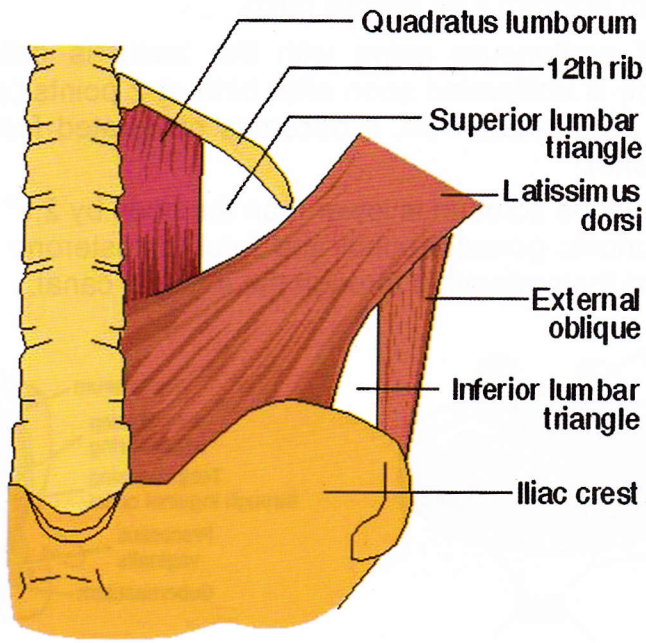
Boundaries:

- **Medial**: latissimus dorsi.
- **Base**: iliac crest.
- **Lateral**: external oblique.

Floor:

- internal oblique

Surgical Importance: lumbar hernia



Testis

Embryology

- Develops from the genital ridge between the 10th & 12th dorsal segments.

MCQ **Surgical Importance:** Testicular nerves develop from T10-T12, so testicular pain may be felt around the umbilicus.

- Wolffian ducts become epididymis & vas deferens.
- Gubernaculum joins the testis (at junction of vas & epididymis) with the scrotum and it plays a role in the descent of the testis. After birth it represents the scrotal ligament.

MCQ

Descent of the Testes

MCQ - At the 6th month of the intrauterine life, they lie at the internal inguinal rings (common site for undescended testis).

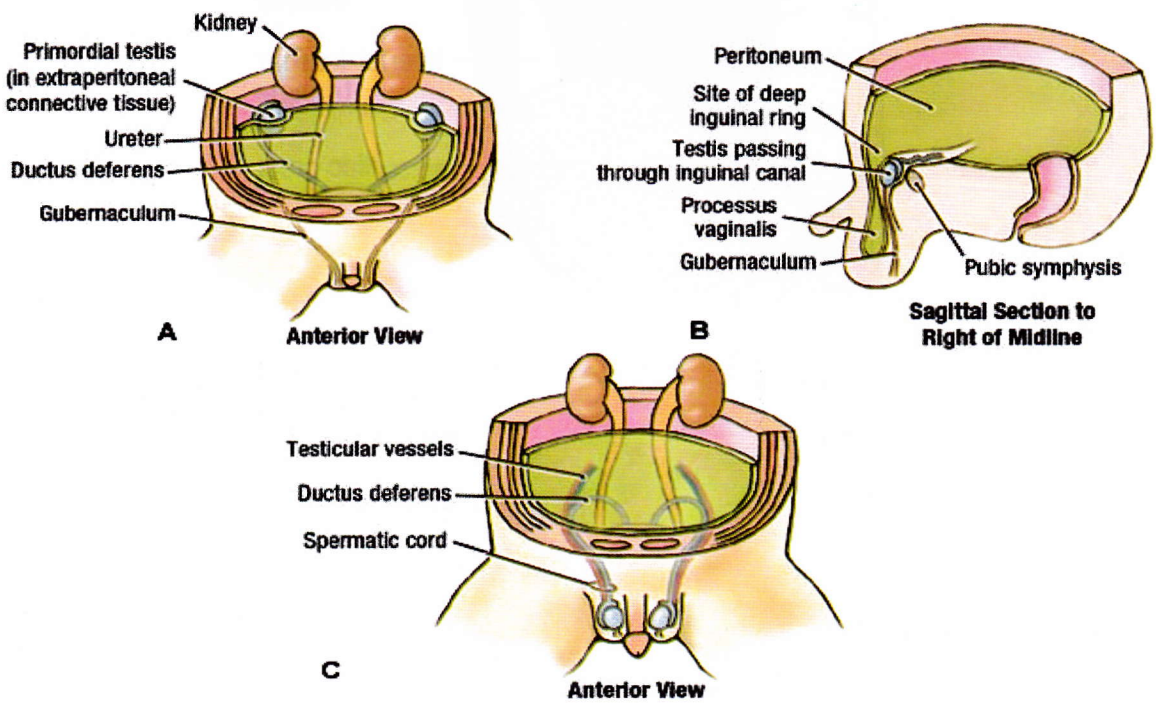
- At 7th month they go through the inguinal canal.

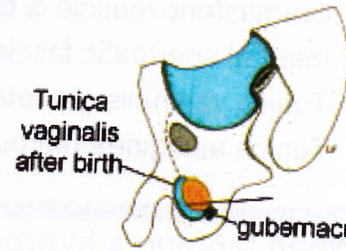
MCQ - At 8th month they lie at the external inguinal rings or at the neck of scrotum.

- They descend to scrotum **just before birth**.
- Invagination of peritoneum going with the testis is called the **processus vaginalis**, which is obliterated soon after birth at 2 points (at the internal ring & just above the testis). Later on, it becomes obliterated forming a fibrous cord **(Tunica vaginalis)**.

➢ Temperature in the scrotum is lower than the body by 2.5° (i.e. 35°).

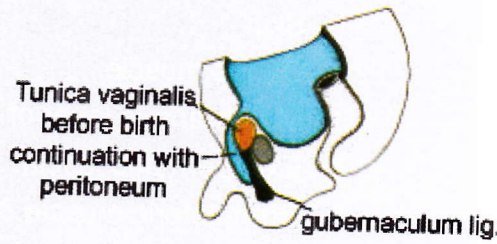
➢ Maternal chorionic gonadotrophin and fetal testosterone stimulate growth of the testes and their migration through the inguinal canal.





Factors affecting descend of testis:

- Differential body growth
- Gubernaculum
- +ve pressure in the abdomen
- HCG → ↑ Size



ANATOMY

Size:

Testis is an ovoid structure 4 - 5 cm in length & 2.5 - 3.5 cm in width.

Shape:

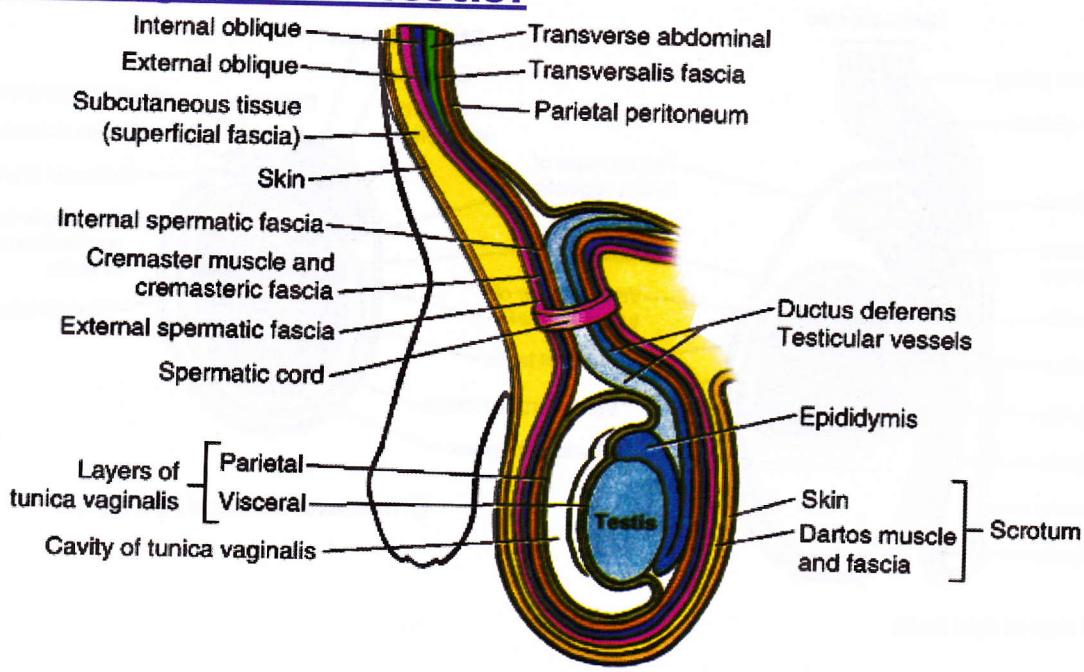
It is oval in shape, having 2 borders (anterior & posterior), 2 ends (upper & lower) & 2 surfaces (lateral & medial).

Relations:

Its posterior border is related to:

- Epididymis: laterally
- Vas deferens: medially

Coverings of the testis:



1. Skin
2. Dartos muscle
3. Colle's fascia
4. External spermatic fascia

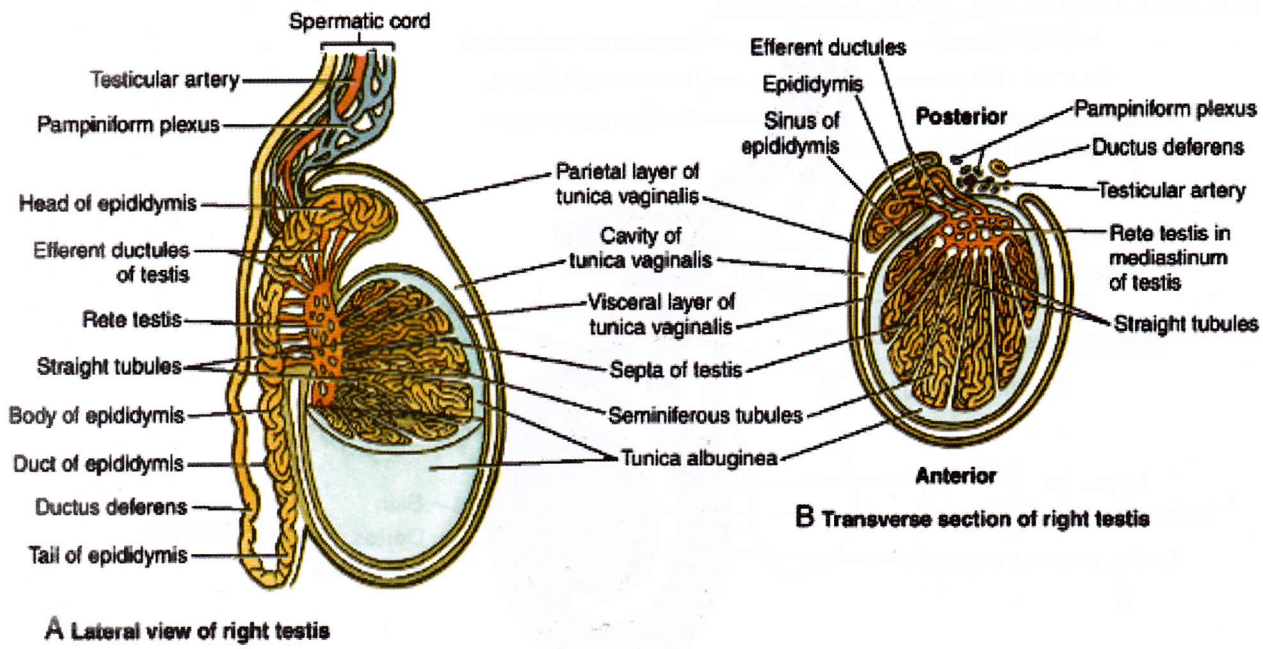
5. Cremasteric muscle & fascia
6. Internal spermatic fascia
7. Tunica vaginalis (parietal & visceral layers).
8. Tunica albuginea (fibrous capsule).

N.B: When tapping a hydrocele, the cannula traverses: MCQ

1- Skin
2- Dartos muscle.
3- Membranous layer of superficial fascia.
4- Ext spermatic fascia.
5- Cremasteric muscle & fascia.
6- Internal spermatic fascia.
7- Parietal layer of tunica vaginalis (not visceral layer).

Structure:

- The testis is covered by thick fibrous layer (tunica albuginea), which is thickened posteriorly to form the mediastinum testis. It sends septa that divide the testis into 400 spaces, each contains 2-4 semineferous tubules which are 60 cm in length.
- The semineferous tubules open into rete testis in the mediastinum testis.
- The rete testis forms the vasa efferentia (15-20).
- The semineferous tubules are surrounded by vascular connective tissue contains Leydig cells that secrete testosterone.

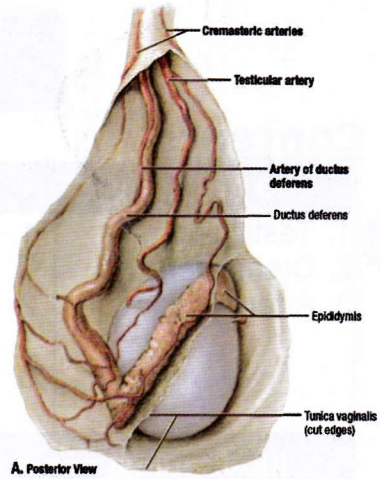


Blood Supply:

Arterial Supply

1- Testicular artery from the Aorta.

2- Artery to vas (from inferior vesical artery). It may be efficient to maintain the testicular viability when the testicular artery is divided, however, testicular atrophy might occur (2%).

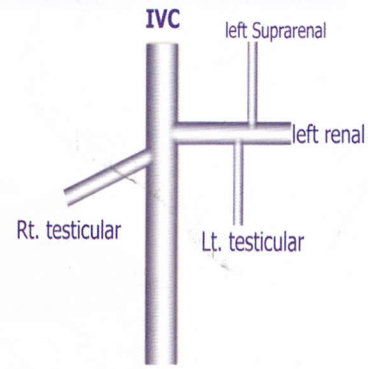


Venous Drainage

1- Testicular veins are formed from the pampiniform plexus of veins which are the most bulky constituents of the cord.

- It is formed of about 20 veins.
- They reduce in number upwards till reaching about 4 in the inguinal canal then one vein retroperitoneally.

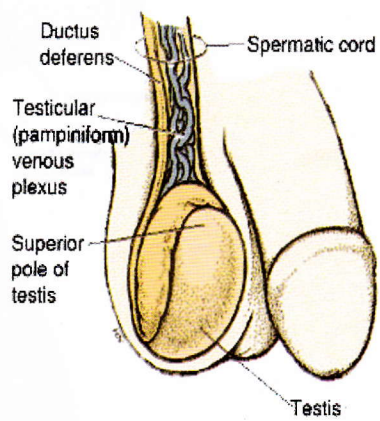
MCQ **Rt. testicular vein** → directly to IVC.
Lt. testicular vein → left renal vein.



2- Cremasteric veins anastomose freely with the testicular veins. They form mainly the anterior compartment of the cord & end in the inferior epigastric vein.

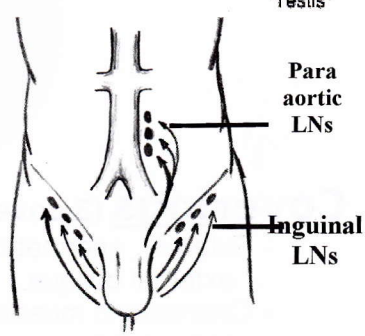
3- Vein of vas ends in the internal iliac vein.

4- Vein of the gubernaculum.



Lymph Drainage

MCQ
- Testis → Para-aortic LNs (at the level of L1).
- The scrotum →inguinal LNs (medial group of superficial inguinal LNs).



Surgical Importance:

Seminoma may infiltrate the inguinal LNs in case of scrotal infiltration.

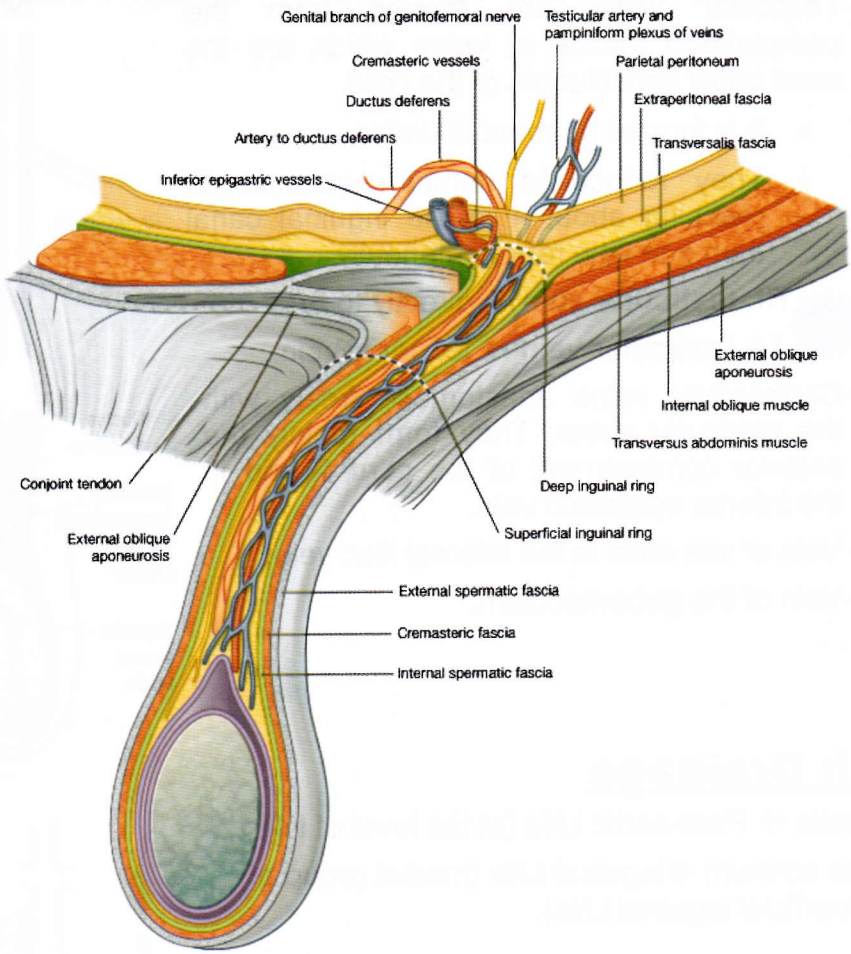
Spermatic Cord

Contents

MCQ

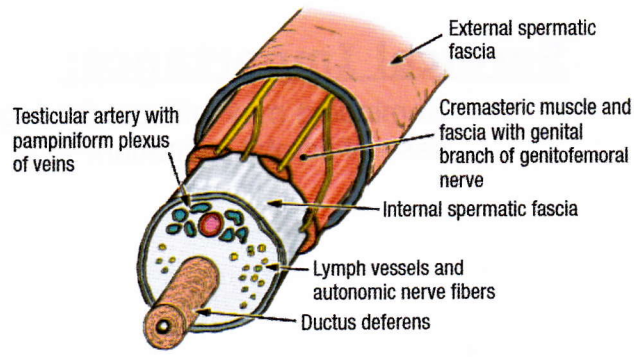
3 Arteries	3 Nerves	3 Structures
1. Testicular 2. Cremasteric 3. Artery of vas.	1. Genital branch of Genito-femoral n. 2. Sympathetic ns. around testicular a. 3. Sympathetic ns. around artery of vas.	1. Pampiniform plexus. 2. Vas deferens. 3. Obliterated processus vaginalis (Vestige).

Ilio-inguinal nerve is a content of the inguinal canal and NOT the spermatic cord



Coverings (3 coverings)

- External spermatic fascia → from external oblique.
- Cremasteric muscles → from internal oblique & transversus abdominis.
- Internal spermatic fascia → from fascia transversalis.



- ***Inside the Inguinal Canal:***
  Internal spermatic fascia & cremasteric muscle.
- ***Outside the Inguinal Canal:***
  Internal spermatic fascia, cremasteric muscle & external spermatic fascia.

Planes of Anterior Abdominal Wall

- Anterior abdominal wall is divided into quadrants by midline plane and transverse plane (through umbilicus): upper right (UR), upper left (UL), lower right (LR) and lower left (LL).
- **Another method for dividing it into 9 regions:**

Around the umbilicus:

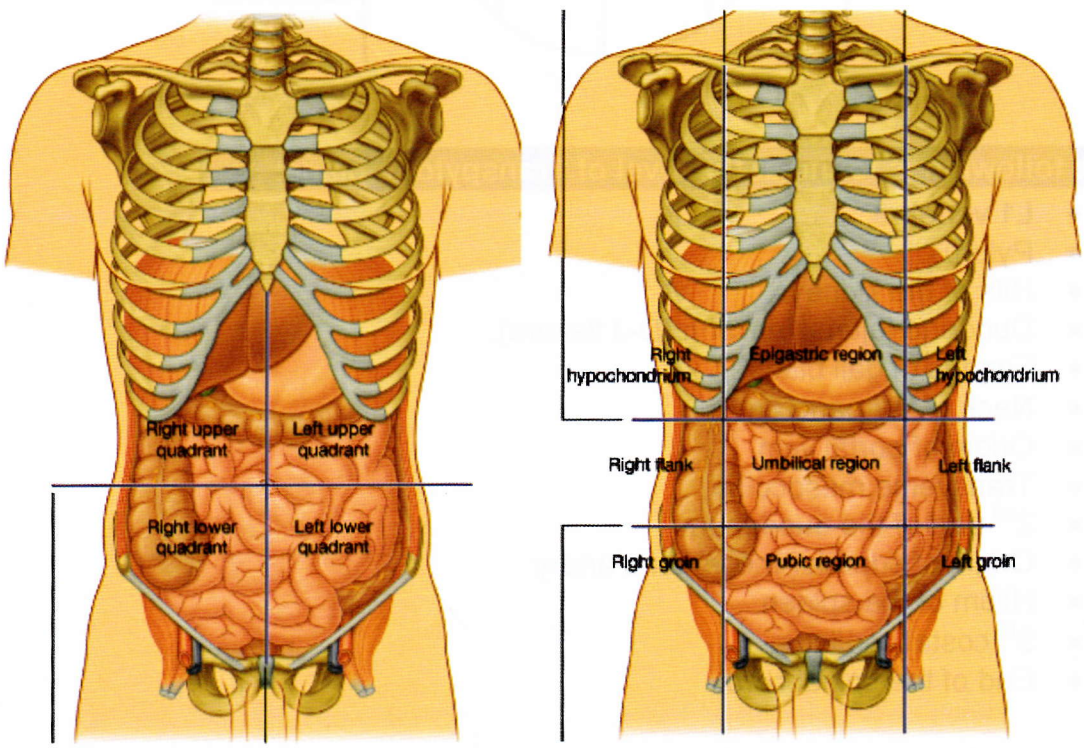
1. **Umbilical** region
2. **Right lateral** (lumbar) region.
3. **Left lateral** (lumbar) region.

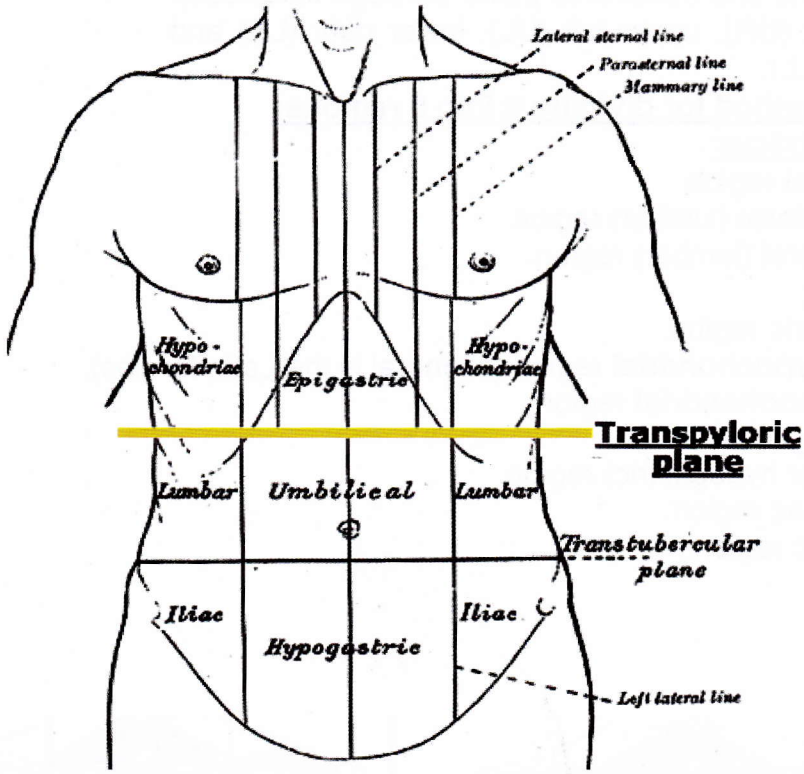
Towards chest:

4. **Epigastric** region.
5. **Right hypochondrial** region (chondral is the Latin for ribs).
6. **Left hypochondrial** region.

Towards pelvis:

7. **Pubic** (or hypogastric) region.
8. **Right iliac** region.
9. **Left iliac** region.





The following is found at the level of Transpyloric plane:

- L1 vertebra.
- Pylorus.
- Hila of the kidneys.
- Duodeno-jejunal junction (D-J flexure).
- Fundus of gall bladder.
- Neck of the pancreas.
- Origin of portal vein.
- Transverse mesocolon.
- 2nd part of the duodenum.
- Origin of superior mesenteric artery.
- Hilum of the spleen.
- 9th costal cartilage.
- End of the spinal cord.

Peritoneum

The peritoneum is the serous membrane that forms the lining of abdominal cavity.

Layers:

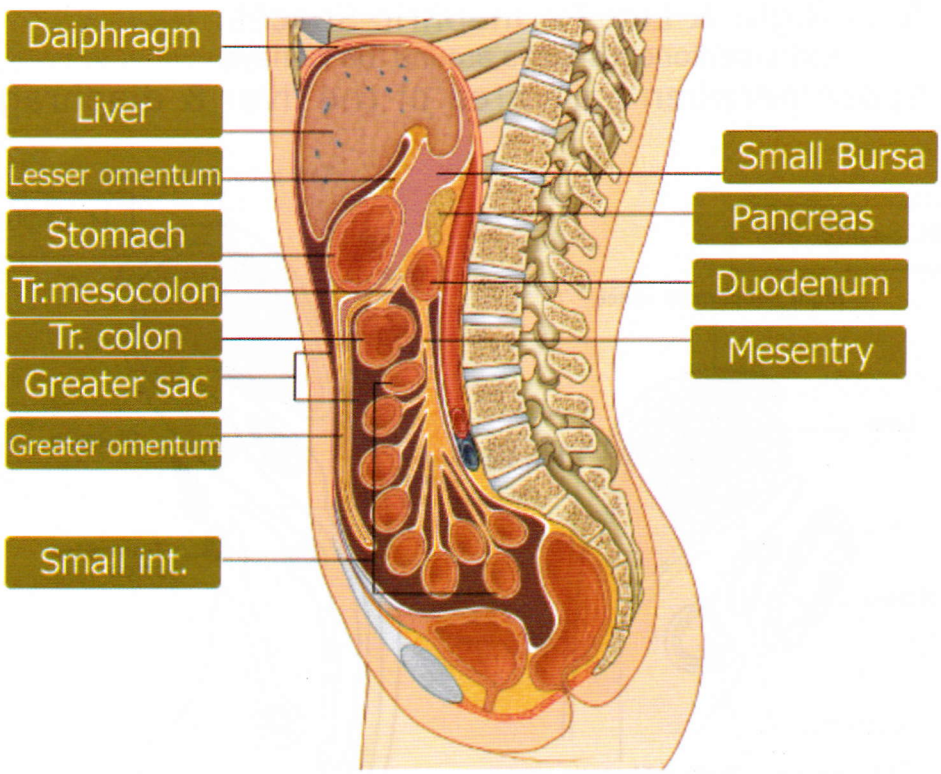
- The outer layer, the **parietal peritoneum**, is attached to the abdominal wall.
- The inner layer, the **visceral peritoneum**, is wrapped around the internal organs that are located inside the intra-peritoneal cavity.
- The potential space between these two layers is the **peritoneal cavity**. It is filled with a small amount (about 50 ml) of serous fluid that allows the two layers to slide freely over each other.

Subdivisions

There are two main regions of the peritoneum, connected by the **epiploic foramen**:

- The greater sac (or *general cavity of the abdomen).*
- The lesser sac (*or omental bursa*) is divided into two "omenta":
  - The lesser omentum (or *gastro-hepatic*) is attached to the lesser curvature of the stomach and the liver.
  - The greater omentum (or *gastro-colic*) hangs from the greater curve of the stomach and loops down in front of the intestines before curving back upwards to attach to the transverse colon. In effect it is draped in front of the intestines like an apron and may serve as an insulating or protective layer.

The mesentery is the part of the peritoneum through which most abdominal organs are attached to the abdominal wall and supplied with blood and lymph vessels and nerves.



Surgical importance:

Pathological Spread of Fluids: The peritoneal recesses are of clinical importance with the spread of pathological fluids like pus that may occur when an organ is injured or diseased. The recesses determine the extent and direction of the spread of fluids that may enter the peritoneal cavity.

Subphrenic spaces

These are peritoneal spaces lying below the diaphragm & may become sites for collection of pus (subphrenic abscess).
They include the following spaces:

A- Intraperitoneal spaces

1) Right anterior:

Between the Rt. lobe of liver & the diaphragm on the Rt. side of falciform ligament.

2) Right posterior (Hepato-renal or Morrison pouch):

- Between posterior surface of Rt. lobe of liver, anterior surface of Rt. kidney and lower layer of coronary ligament of liver.
- It is the **most dependent** part of peritoneal cavity in the **supine position**.
- It is the **commonest site of subphrenic abscess**.

3) Left Anterior:

Between Lt. lobe of the liver, the diaphragm and the Lt. side of falciform ligament.

4) Left Posterior (Lesser sac of Peritoneum):

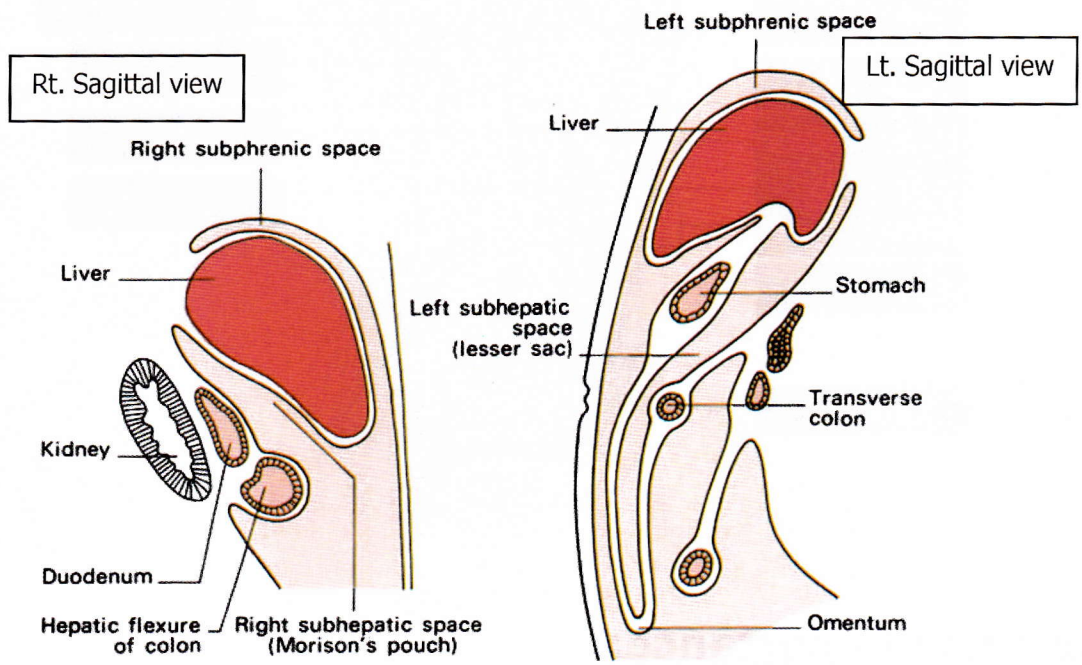
Behind the stomach & lesser omentum.

B- Extraperitoneal spaces

1) & 2) Right & Left Perinephric Spaces:

Extra-peritoneal spaces around the kidneys

3) Space between bare area of the liver & diaphragm.

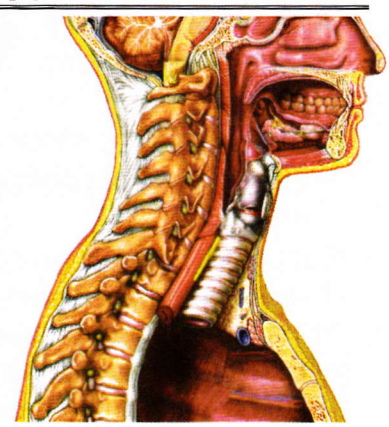


Gastrointestinal Tract

The Esophagus

Parts: **it is a muscular tube (25 cm) with the following parts:**

1- Cervical Esophagus:



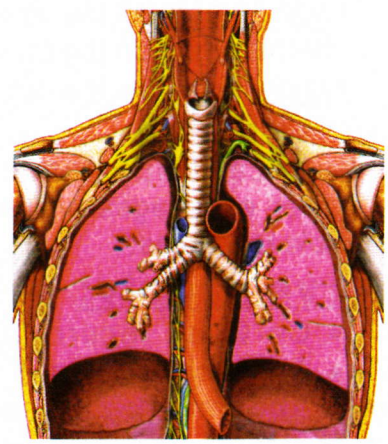
- Lies in front of pre-vertebral fascia slightly to the Lt. behind trachea.

- Starts at level of cricoid cartilage (C6).

Relations:

- ***Anterior***: trachea, recurrent laryngeal nerve.
- ***Posterior***: vertebrae.

2- Thoracic Esophagus:

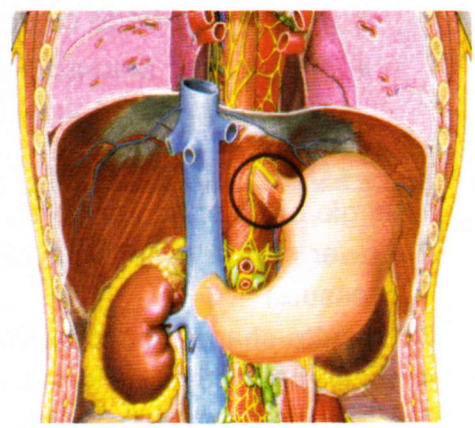


MCQ

Relations:

- ***Anterior:*** trachea, Lt. main bronchus, pericardium, Lt. atrium & Rt. pulmonary artery.
- ***Posterior:*** vertebrae.
- ***Left side:*** arch of aorta, lung, pleura & Lt. vagus.
- ***Right side:*** azygos vein, lung, pleura & Rt. vagus
- **It pierces diaphragm** 1 inch to the left of midline opposite to body of T10 or 7th left costal cartilage.

3- Abdominal Esophagus



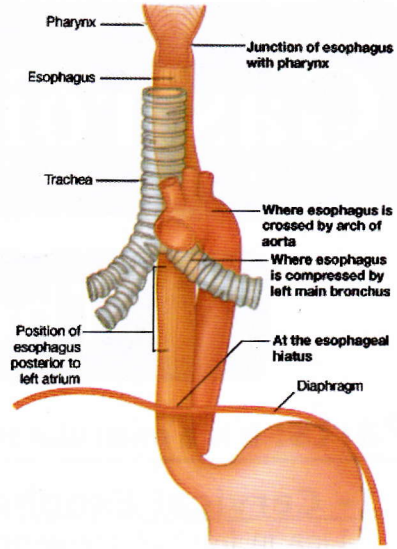
MCQ

- It is about 4 - 5 cm long.
- It ends at the gastro-esophageal junction.
- Peritoneal covering: only anteriorly.
- It is closely related to both gastric nerves (*Anterior* usually lies within its wall; *posterior* is related to it posteriorly).

Constrictions:

From the incisor teeth:

- **15 cm:** cricopharyngeus.
- **25 cm:** aortic arch.
- **27 cm:** left main bronchus.
- **40 cm:** opening in diaphragm.



Surgical Importance:

These are the sites of foreign body impaction.

Blood Supply:

-Arterial supply

MCQ

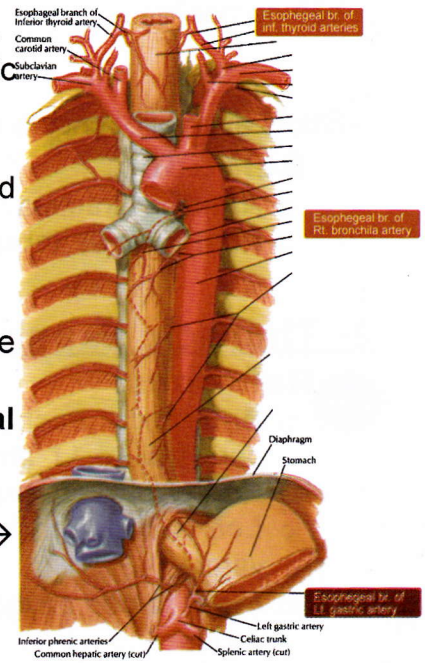
- *Upper esophagus*: supplied by inferior thyroid arteries.
- *Middle portion:* esophageal branches from the aorta.
- *Lower part:* esophageal branches of the left gastric artery.

Surgical Importance:

These are small vessels which can easily be dissected in trans-hiatal esophagectomy.

-Venous Drainage

- *Upper part:* to the brachio-cephalic veins.
- *Middle part*: to the azygos veins on the Rt. & to the hemiazygos on the Lt.
- *Lower part:* to the left gastric vein then the **portal vein**.



Surgical Importance:

Lower esophageal veins lie in the lamina propria → liable to varices.

Nerve supply:

- Cervical: recurrent laryngeal n.
- Thoracic: vagus N.
- Abdominal: autonomic suplly.

Lymph Drainage:

- *In the neck*: Deep cervical LNs.
- *In the chest*: Mediastinal LNs.
- *In the abdomen*: celiac LNs.

Factors controlling Competence of the Cardia:

1) Angle of Hiss: Acute → valvular effect between left side of esophagus & fundus.
2) Lower part of esophagus (5 cm) is intra-abdominal → closed on rise of abdominal pressure.
3) Rosette-shaped mucosal folds of lower end → bulging in the lumen.
4) Pinch-cock effect of Rt. crus of diaphragm.
5) Phrenico-esophageal ligament: Keeping the intra-abdominal part in place.
6) Continuous release of acetyl choline → lower end relaxes only on swallowing.
7) Pressure at lower 5 cm of esophagus is 8 - 25 mmHg while the Intra-gastric pressure is 7 mmHg, thus, no reflux occurs.

Syrface anatomy:

☞ **Mark 3 points:**

1. At the lower border of the cricoid cartilage in the midline.
2. At the sternal angle in the midline.
3. At tke Lt. 7th costal cartilage 2.5 cm from the midline.

☞ **Draw 2 parallel lines 2.5 cm apart by joining the above 3 points**

Points of Surgical Importance:

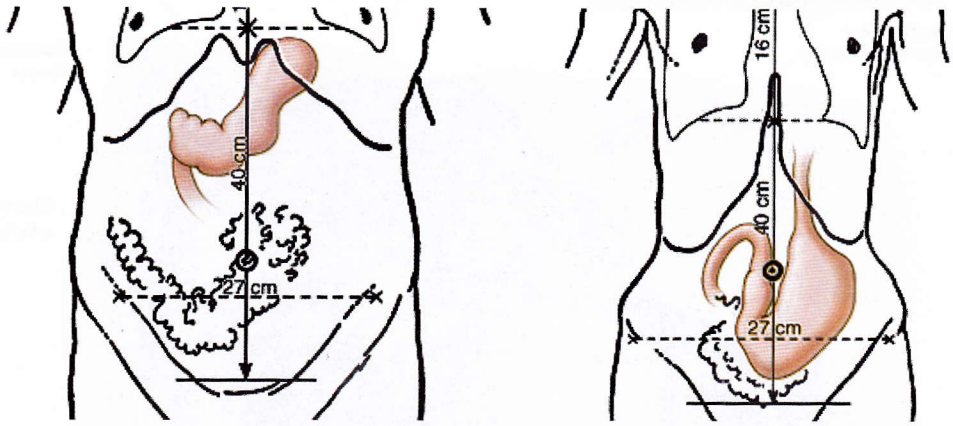
- Endoscopically, the cardia is known by Z-line which is 1 - 4 cm from the anatomical gastro-esophageal junction.
- Lower esophageal sphincter is a functional sphincter. MCQ

STOMACH

Site: Left hypochondrium, epigastrium and umbilical regions.

Shape:

- J-shaped (vertical): **COMMONEST**.
- Steer-horn (horizontal): less common.

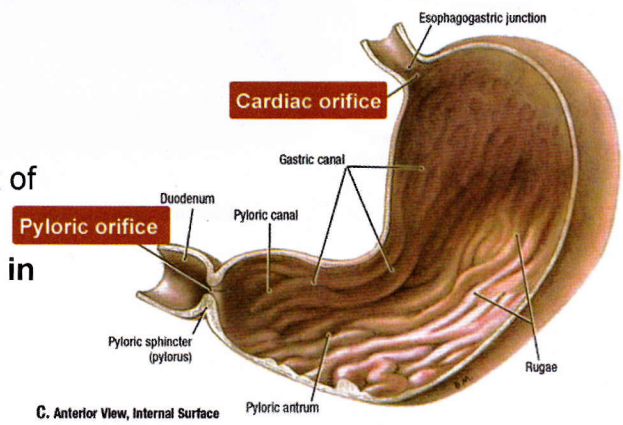


The stomach has 2 orifices, 2 borders & 2 surfaces:

Orifices:

A- *Cardiac orifice:*

- At the junction of the esophagus.
- At the level of T10, 1inch to the left of the midline.
- **At 45 cm from incisors in endoscopy.**



B- *Pyloric orifice:*

- At the junction with the duodenum.
- At the level of L1, ½ inch to the right of the midline. MCQ
- ***Identified at operation by:***
  1. Pre-pyloric vein of Mayo between Rt. gastric and Rt. gastro-epiploic veins.
  2. Annular groove. MCQ
  3. Feeling its thickness.

Borders:

Lesser curvature & greater curvature (4 times long as the lesser curvature).

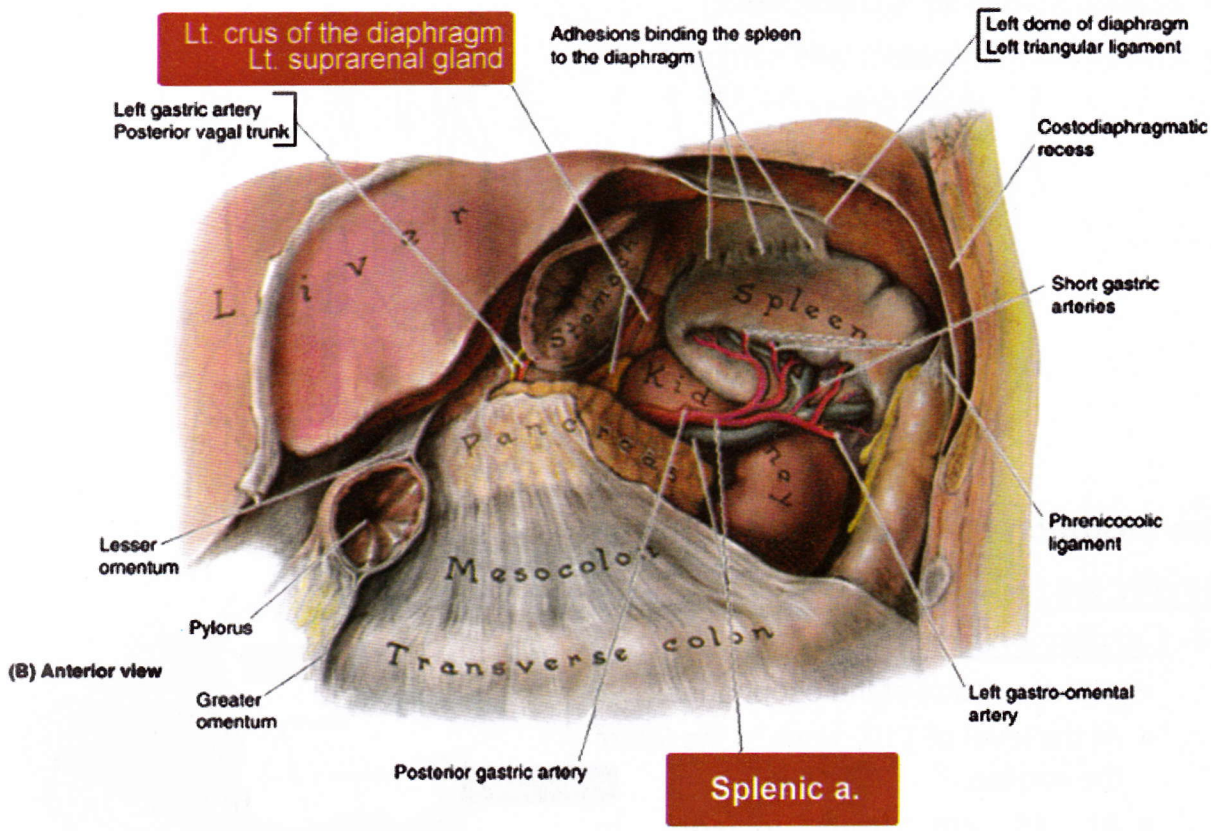
Surfaces:

A-*Anterior:* related to the liver, diaphragm, & ant abdominal wall

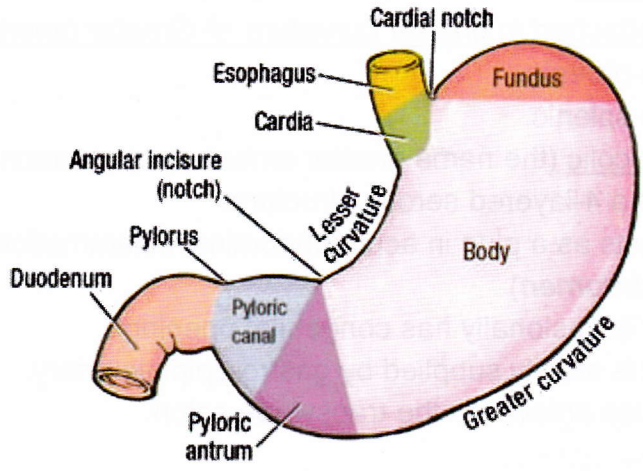
B-*Posterior:* (The Stomach Bed) MCQ

1- Lt. crus of diaphragm.
2- Lt. suprarenal gland.
3- Lt. kidney.
4- Spleen (separated by greater sac).
5- Splenic artery.
6- Body of pancreas.
7- Transverse mesocolon.
8- Transverse colon.

N.B. all are separated from the stomach by lesser sac **except spleen** which is separated by greater sac. MCQ



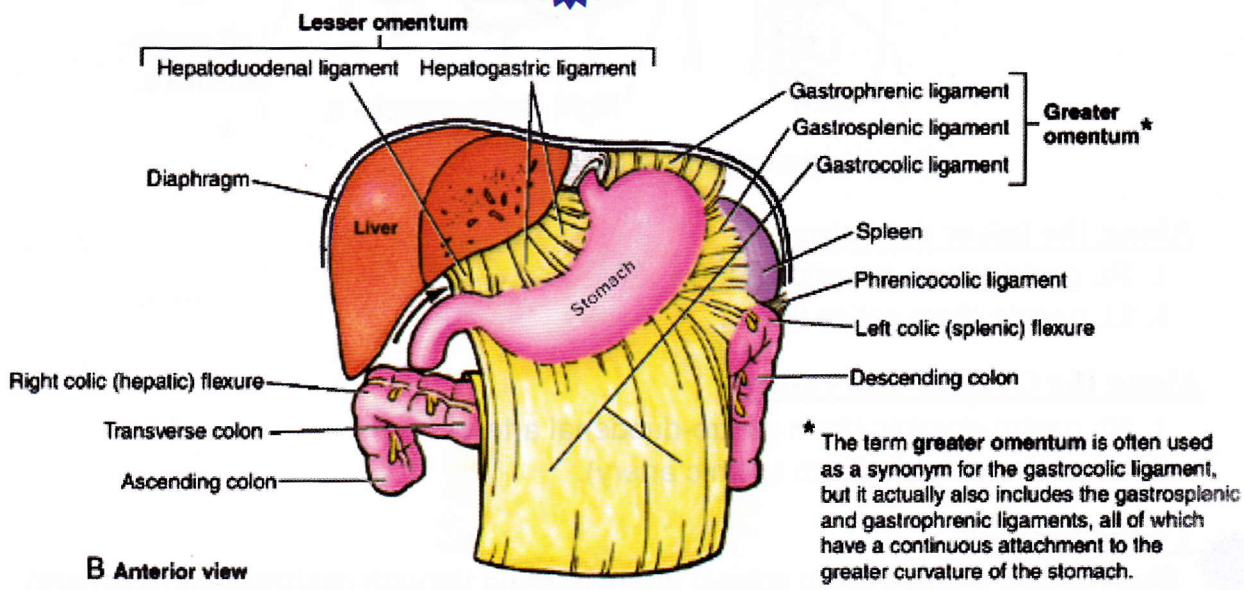
Parts of the Stomach:



A. Anterior View

1. **Fundus:** above the level of cardiac notch.
2. **Body:** between the fundus & the pyloric portion.
3. **Pyloric portion:**
   - Distal to imaginary line between incisura angularis to corresponding bulge in the greater curvature.
   - It consists of 3 parts:
     - i- ***Pyloric antrum*** → proximal dilated part.
     - ii- ***Pyloric canal*** → distal narrow part.
     - iii-***Pyloric sphincter*** → at the end of the stomach.

peritoneal covering: MCQ



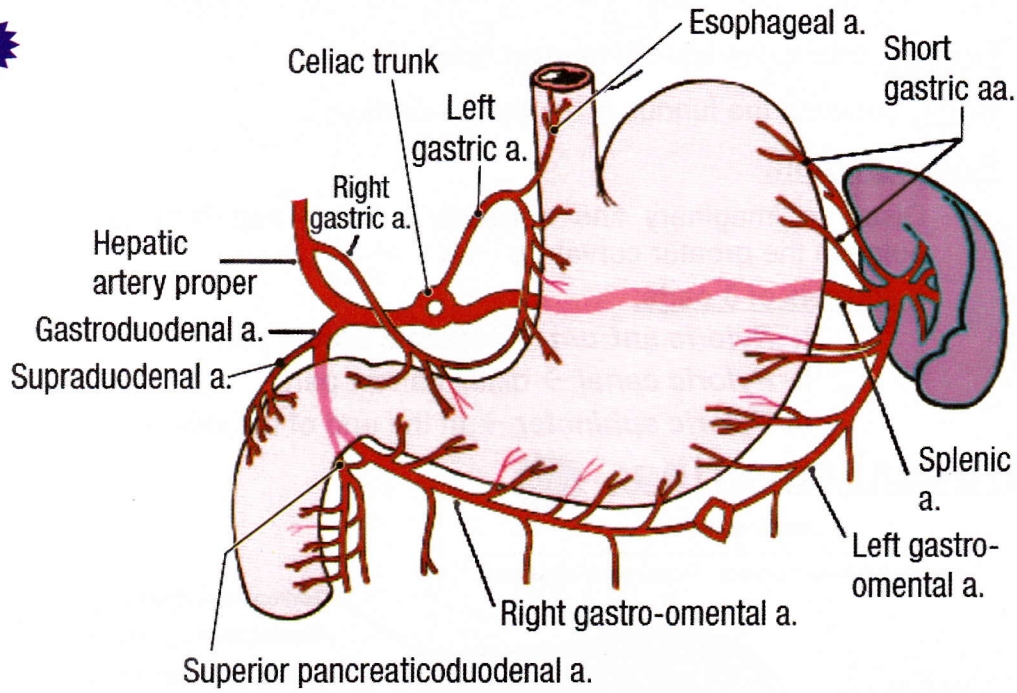
B Anterior view

- completely covered with peritoneum

- **Ligaments attached to it:**
  - Lesser omentum attached to the lesser curvature.
  - *Ligaments attached to greater curvature → Greater omentum, including:*
    1. Gastro-phrenic.
    2. Gastro-splenic.
    3. Gastro-colic (the name greater omentum is commonly used for this):
       - Is a 4-layered serous structure.
       - Acts as a plug in acute abdominal inflammation (***Policeman of the abdomen***)
       - It occasionally has congenital openings.
       - It is mainly supplied by gastro-epiploic artery.
       - Lies anterior to the transverse colon.

Arterial Supply: *Supplied by branches of celiac trunk (foregut)*

MCQ



Along the lesser curvature

i. Rt. gastric (from hepatic artery).
ii. Lt. gastric (from celiac trunk).

Along the Greater Curvature

i. Rt. gastro-epiploic (from gastro-duodenal artery).
ii. Lt. gastro-epiploic (from splenic artery).

MCQ

To the Fundus

Short gastric arteries (from splenic artery passing through gastrosplenic ligament).

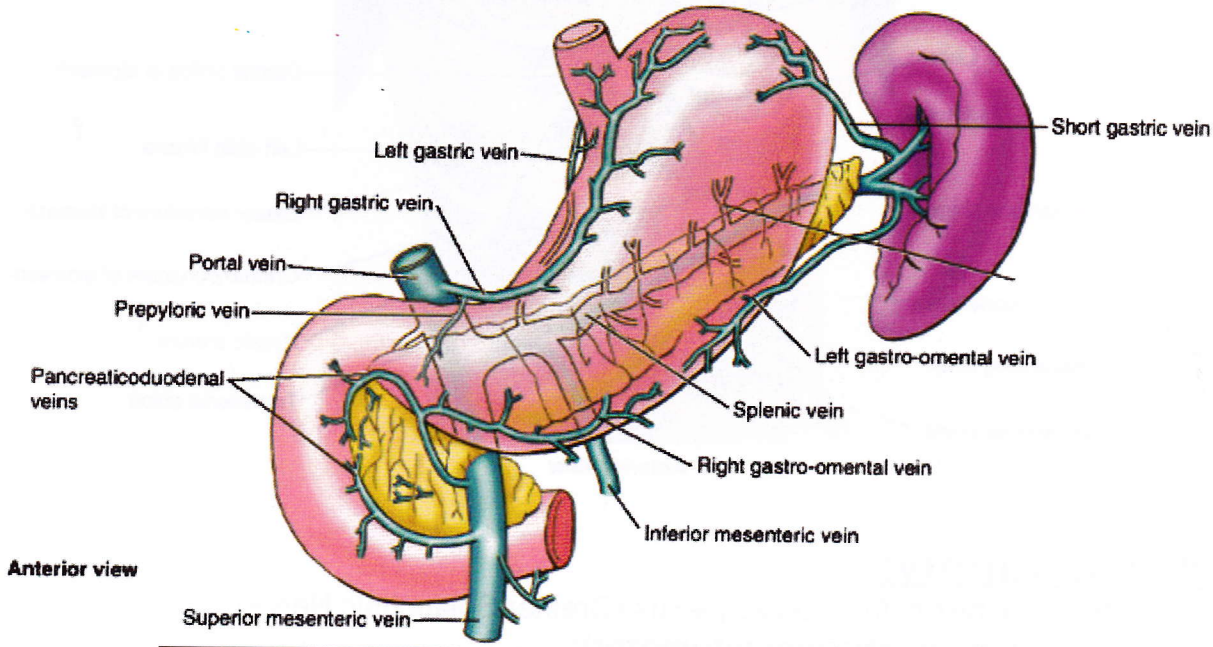
Surgical Importance:

In subtotal gastrectomy, the land mark is the upper border of descending branch of lt. gastric a. & the last short gastric a.

Venous Drainage: *(Portal + anastomosis with esophageal veins)*

MCQ

1) Rt. & Lt. gastric veins → portal vein.
2) Rt. gastro-epiploic vein → superior mesenteric vein.
3) Lt. gastro-epiploic vein & short gastric veins → splenic vein.

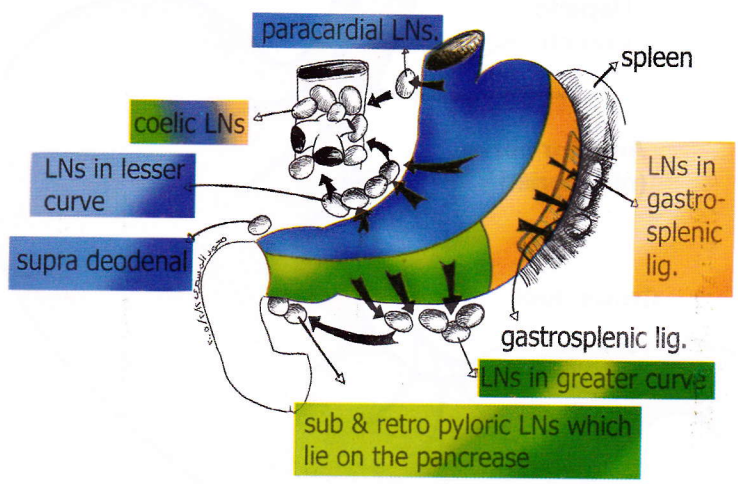


Lymphatic drainage of the stomach

MCQ

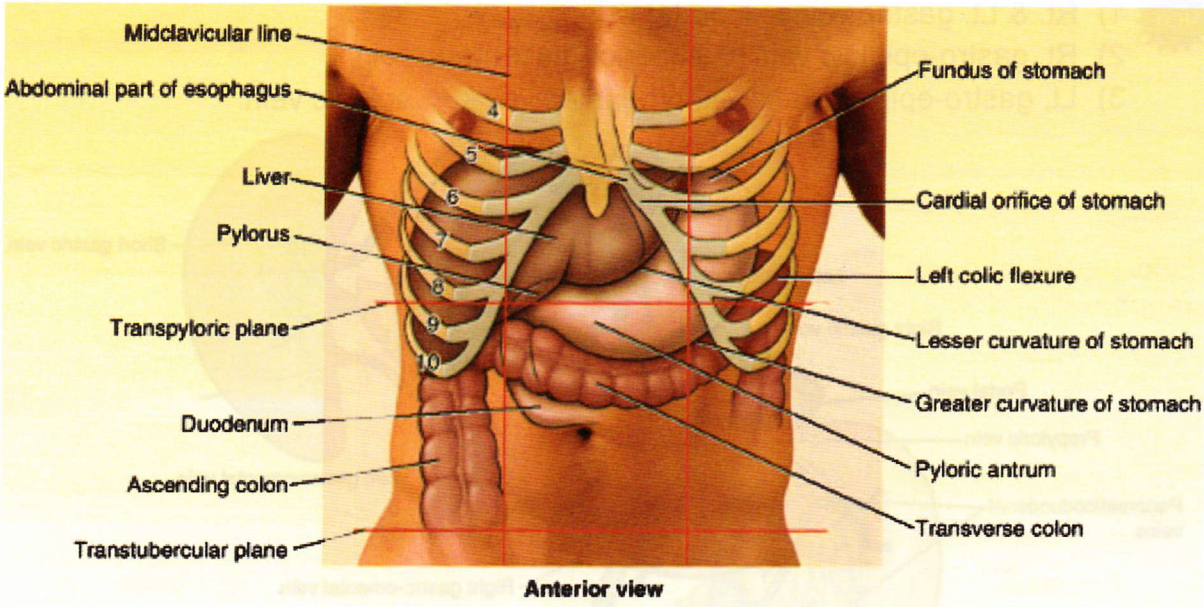
- Right 1/3 → LN on the lesser curve
- Left 2/3
  - Upper 1/3 → LN in gastro-splenic ligament
  - Lower 2/3 → LN on greater curve
- Sub-pyloric & retro-pyloric
- Celiac LNs

The lymph vessels are in the stomach itself



LYMPH DRAIN OF THE STOMACH

Surface anatomy:



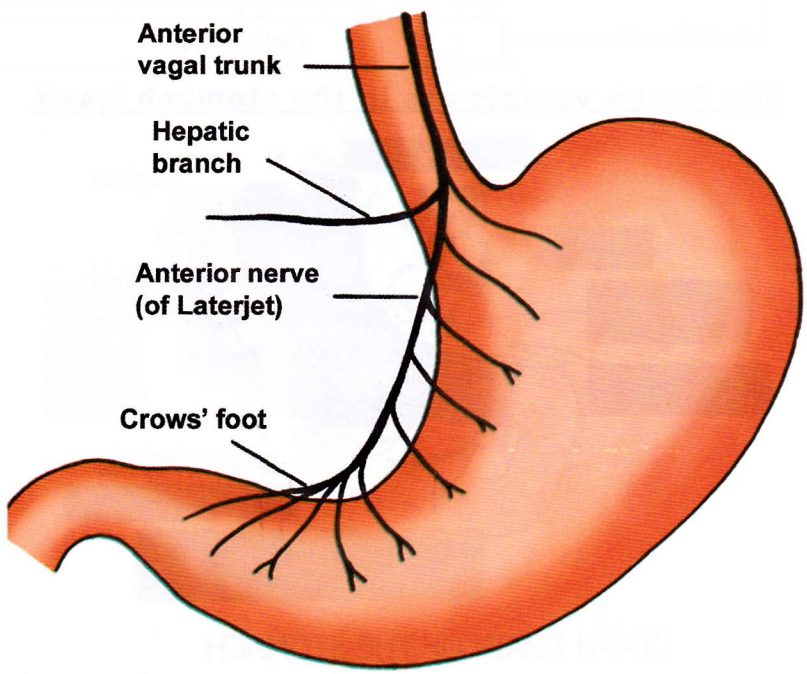
Anterior view

Nerve Supply:

A- Sympathetic: from celiac plexus (Greater Splanchnic Nerve).

B- Parasympathetic (secretomotor):

	Anterior vagus	Posterior vagus
Site in chest	Left	Right
Branches in abdomen	Hepatic	Celiac
Continues as	Ant. nerve of Laterjet	Post. nerve of Laterjet
End by	Crow's foot	No crow's foot



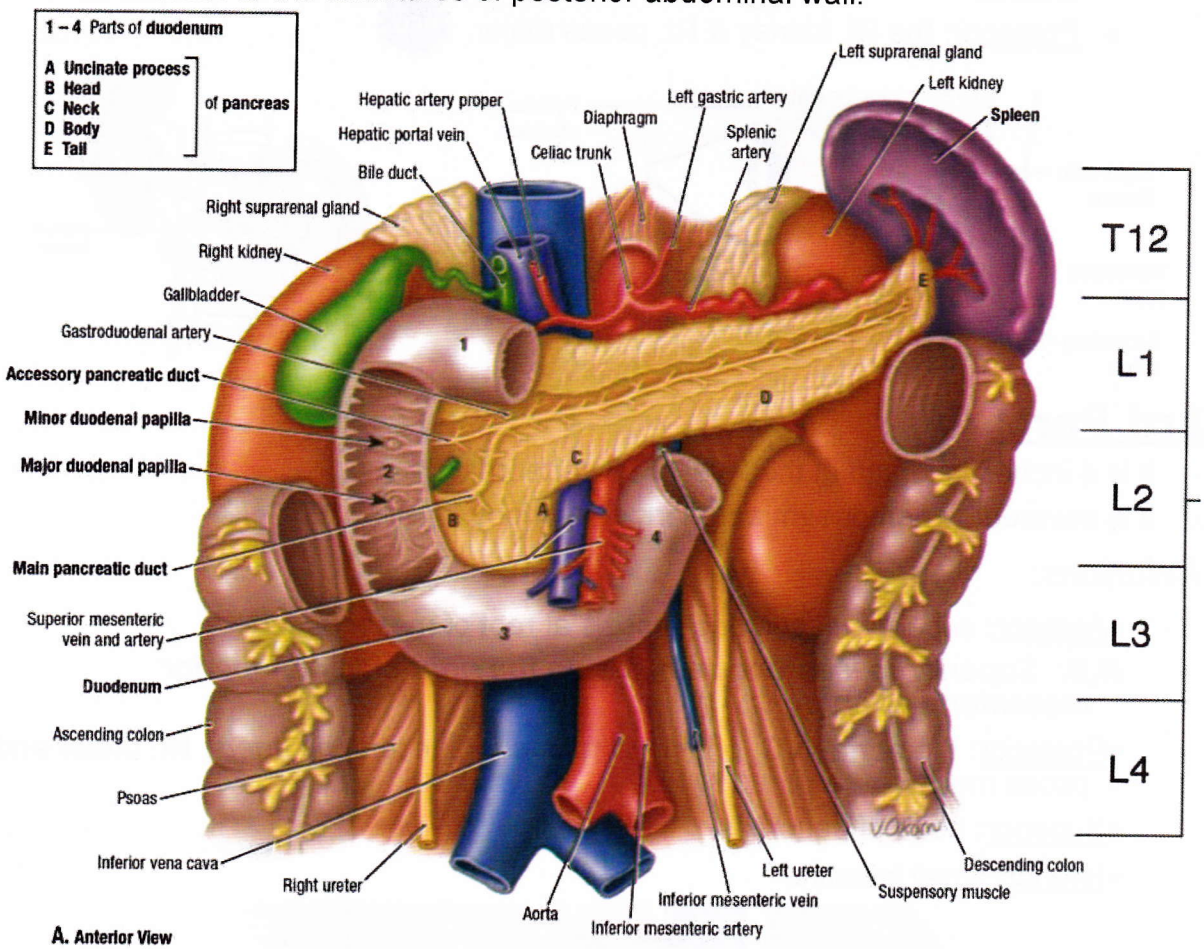
DUODENUM

MCQ

- It is the shortest, widest & most fixed portion of the small intestine.
- It is usually the breadth of **12 fingers**.
- It forms a C - shaped curve around the head of the pancreas.

Peritoneal Covering:

- Duodenum has no mesentery (it is the fixed portion of small intestine → retroperitoneal) except for the 1st part.
- It lies anterior to the structures of posterior abdominal wall.



A. Anterior View

Parts Of The Duodenum: *It is subdivided into 4 parts*

1st Part: (2inches long)

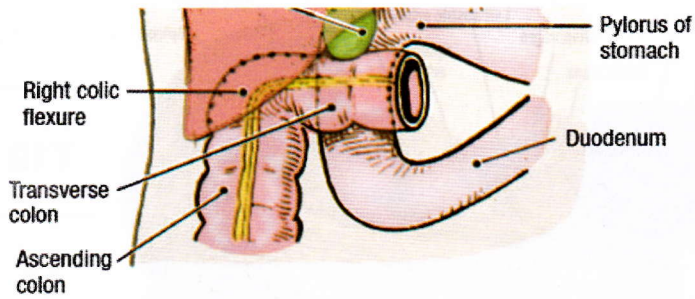
- It is 2 inches long & begins at the level of the L1 vertebra.
- It is the only mobile part of the duodenum (specially the 1st inch).
- It is covered anteriorly by peritoneum of greater sac.
- It is covered posteriorly by peritoneum of the lesser sac.

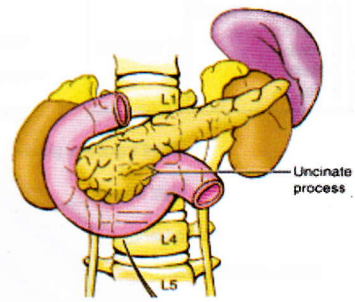
Relations:

- **Superiorly:** Epiploic foramen. MCQ
- **Inferiorly**: Head of pancreas.
- **Posteriorly**: Gastro-duodenal artery, CBD, portal vein & IVC (from anterior to posterior).
- **Anteriorly**: quadrate lobe of liver & neck of GB.

2nd Part:

- It is 3 inches long descending vertically from L1 to L3.
- The bile duct opens in its postero-medial aspect.
- The bile duct usually unites with the main pancreatic duct to form the ampulla of Vater & opens at the major duodenal papilla.
- **The accessory pancreatic duct** opens separately at the **minor duodenal papilla** 1 inch above the major duodenal papilla. MCQ
- *Relations:*
  - Anterior: the liver & the transverse colon.
  - Posterior: the Rt. kidney & Rt. psoas major. MCQ





3rd Part: MCQ

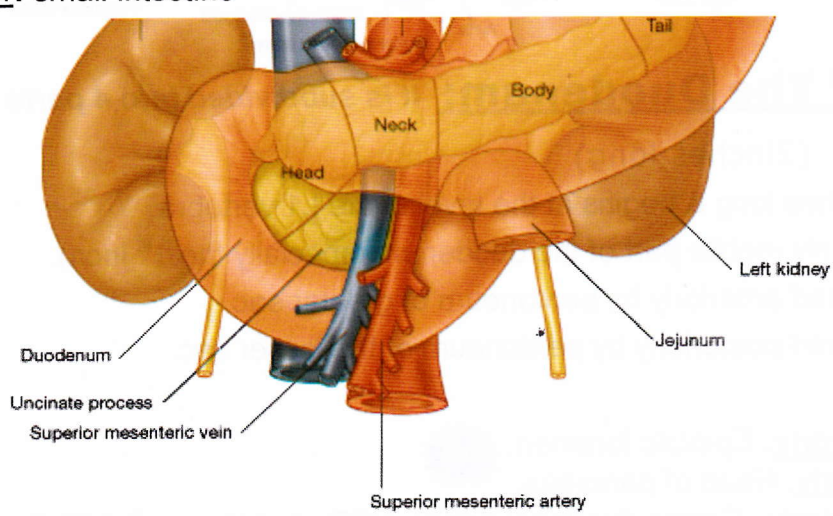
- It is 4 inches in length at the level of L3 vertebra.
- It is covered by peritoneum anteriorly & inferiorly.

Relations:

- Anterior: *superior* mesenteric vessels at root of mesentry.

N.B: Superior mesenteric vein lies on the right side of superior mesenteric artery

- Posterior: the aorta, IVC, origin of the *inferior mesenteric artery*, Rt. ureter and psoas major.
- Superior: head of pancreas
- Inferior: small intestine



4th Part:

- It is 1 inch long.
- It is covered by peritoneum anteriorly & to the Lt.
- It ends at the D-J flexure which is supported by **ligament of Treitz** from the Rt. crus of the diaphragm.

MCQ

Posterior relations:

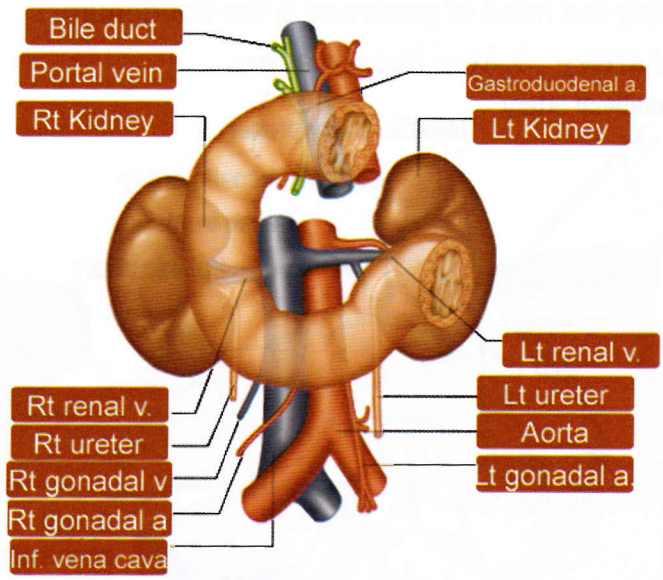
- Medial border of Lt. psoas major muscle.
- Lt. renal vessels.
- Lt. sympathetic chain.
- Lt. gonadal vessels.

Anterolateral relations:

- Coils of jejunum.

Medial relations (and to the Rt.):

- Uncinate process of the pancreas.
- Abdominal aorta.
- Vertebral column.



Ligament of treitz:

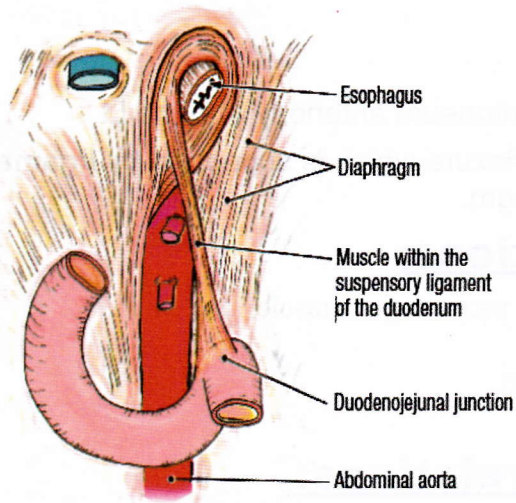
2 parts, probably neither attached to crura

1. Slip of striated muscle from diaphragm at esophageal opening, ending in connective tissue of celiac artery.
2. Fibro-muscular (non-striated) band from region of celiac a. to D-J, 3rd and 4th parts of the duodenum.

Bleeding above this ligament → hematemesis + melena, while below this ligament → melena & if massive, bleeding per rectum occurs.

Bleeding per rectum & not melena occurs if bleeding is from the beginning of the hindgut.

The small gut is suspended by its mesentery which extends from the left side of the 2nd lumbar vertebra to the Rt. iliac fossa crossing the 3rd part of the duodenum, aorta, IVC, Rt. ureter.



Blood Supply:

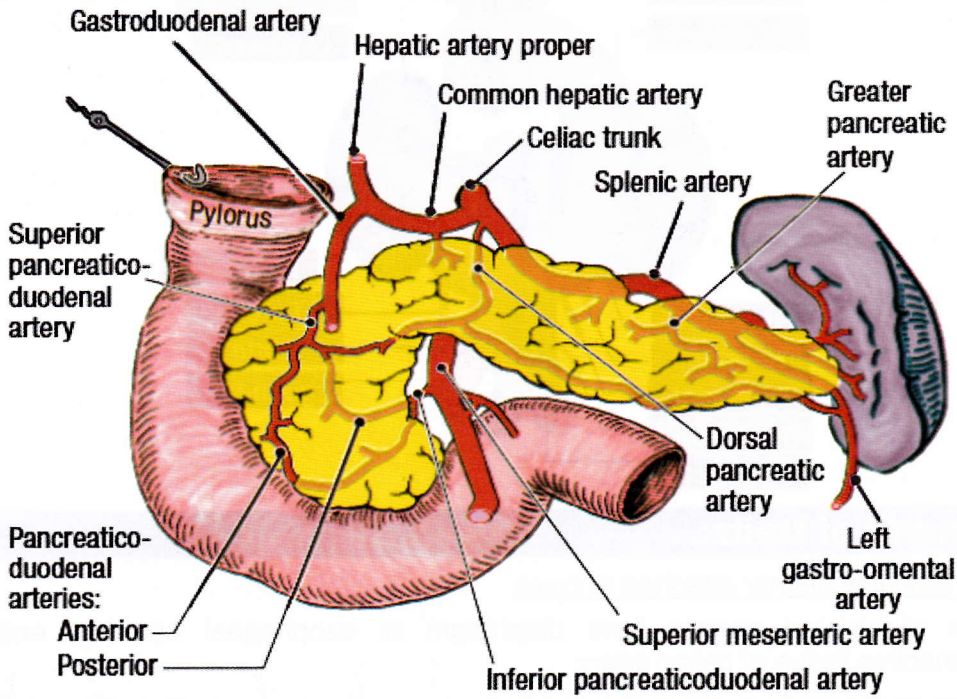
Supplied by branches of both celiac trunk & sup mesenteric a (foregut + midgut)

a- ***Superior pancreatico-duodenal artery*** → from the gastro-duodenal artery.

b- ***Inferior pancreatico-duodenal artery*** → from superior mesenteric artery.

Both of them supply the head of pancreas & the duodenum.

c- ***Supra-duodenal artery*** → from hepatic artery.



Points of Surgical Importance:

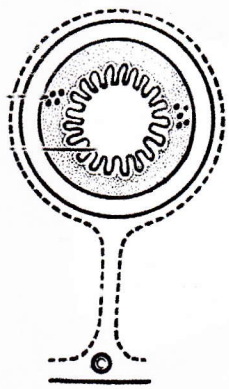
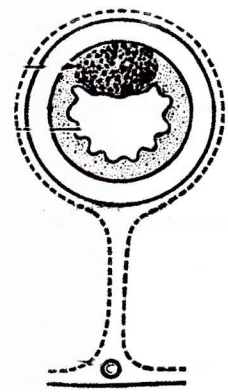
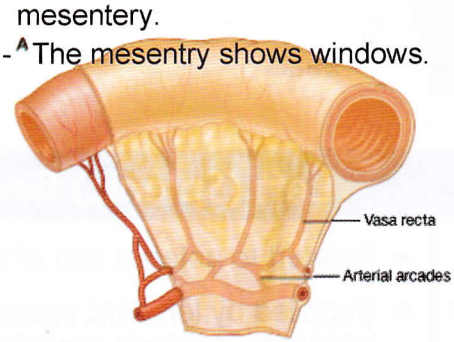
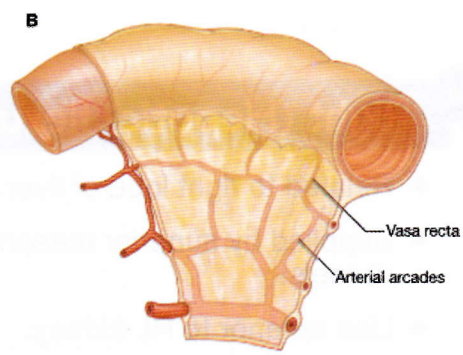
1) ***Obstruction of 3rd part of the duodenum may be caused by:***
   - Pressure by superior mesenteric artery.
   - Contraction of the ligament of Trietz.

2) ***In barium meal:***
   - Widening of C-curve of the duodenum → cancer head of pancreas.
   - Inverted figure 3 → peri-ampullary carcinoma.
   - Trifoliate deformity → duodenal ulcer.

SMALL INTESTINE

MCQ ***Mesentery of the small intestine:*** it is fan-shaped peritoneal fold having:

- **Free border**: *6* meters long enclosing jejunum & ileum.
- **Root**: *6* inches long and is attached to the posterior abdominal wall crossing *6* structures:
  1) 4th part of duodenum
  2) 3rd part of duodenum
  3) Aorta.
  4) IVC
  5) Rt. Psoas major muscle
  6) Rt. ureter
- **Extension:** It extends from left side of L2 to Rt. sacroiliac joint.
- **Contents:**
  1) Coils of jejunum & ileum.
  2) Superior mesenteric artery.
  3) Superior mesenteric vein.
  4) Lymphatics & LNs.

	Jejunum	Ileum
	Proximal 2/5	Distal 3/5
Diameter	Larger diameter	Smaller diameter
Villi	Large	Small
Payer's patches	Less 	More numerous 
Mesentery	- Few lymphoid follicles. - Small amount of mesenteric fats. - Has 1 or 2 arterial arcades in the mesentery. - A The mesentry shows windows. 	- More LNs - Large amount of mesenteric fats. - Has 2 or 3 arterial arcades. - Windows aren't apparent. B 
wall	- Thick & vascular	- Thin & less vascular.

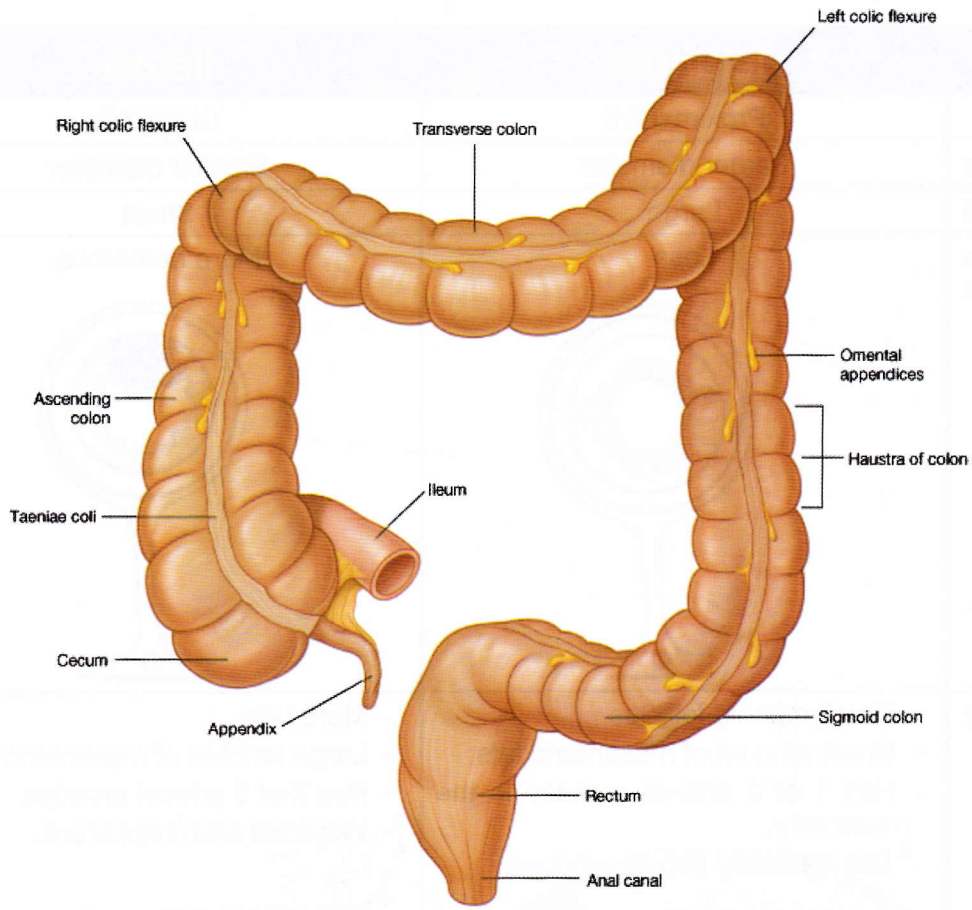
LARGE INTESTINE

Begins: at the end of the ileum, at the ileo-caecal valve.

Ends: at the anal canal (recto-anal junction).

Parts:

- Caecum
- Appendix
- Ascending colon
- Hepatic flexure
- Transverse colon
- Splenic flexure
- Descending colon
- Pelvic colon
- Rectum
- Anal canal



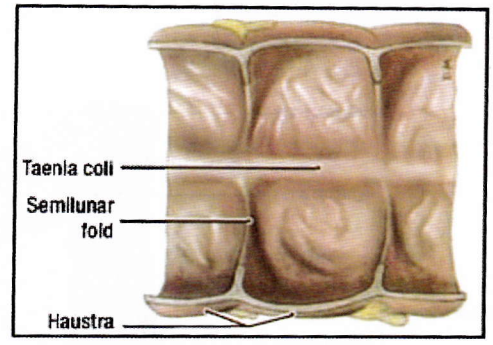
MCQ

Right (Hepatic) flexure	Left (Splenic) flexure
• Related to right lobe of liver.	• Related to anterior end of spleen.
• Supplied by superior mesenteric vessels.	• Supplied by left colic vessels of inferior mesenteric vessels.
• Lies anterior to Rt. kidney.	• Supported by phrenico-colic ligament
	• Lies higher than right colic flexure.

The Large Intestine is characterized by

MCQ

1. Haustrations: due to the presence of taenia coli which is shorter than the length of the intestine (in ulcerative colitis, the large intestine is fibrosed → loss of haustrations).
2. Appendices epiploicae (more in the left).



MCQ

N.B:

- Transverse colon is the longest segment of the colon.
- Sigmoid colon makes an S-shaped course.
- By endoscopy, the promontory of the sacrum might be clinical landmark between cancer rectum & sigmoid colon.
- By endoscopy, recto-sigmoid junction is 15 cm from the anal verge.

Peritoneal converings:

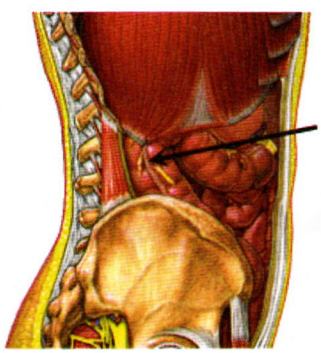
1. **Ascending & descending colons** are covered on the front and sides by peritoneum, not from behind (retro-peritoneal – no mesentery).

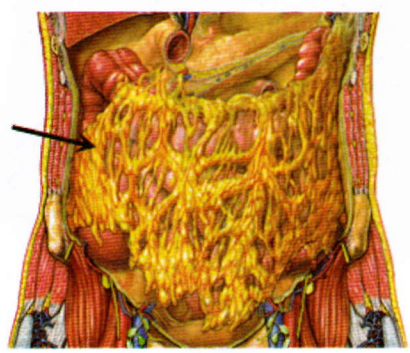
N.B: *A mesentery for the ascending colon & descending colon might be abnormally present & this may lead to volvulus of the caecum & intussusception.*

2. **Transverse colon** has a transverse mesocolon ***(mobile segment)***, which is formed of 2 layers *attached to the anterior border of the pancreas.*

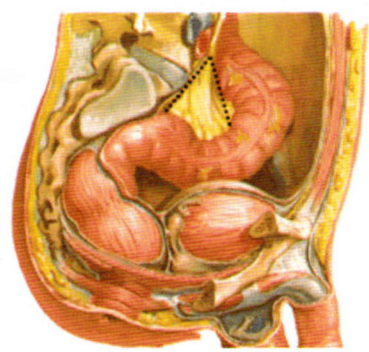
MCQ

3. **Sigmoid colon** has a sigmoid mesocolon. This mesocolon:
   - It has 2 limbs, meeting each other to form inverted V-shaped mesentery.
   - Its apex is directed upwards (lies near the division of left common iliac artery).
   - The left ureter descends behind the apex.
   - Superior rectal vessels run along the right limb.



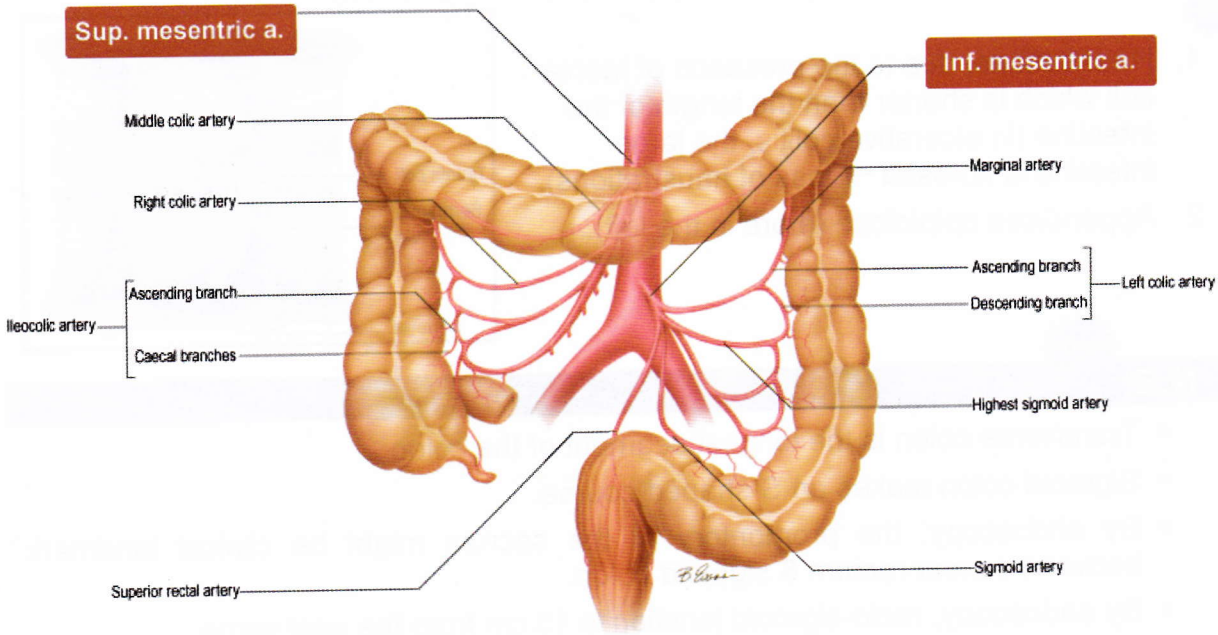


Ascending & descending colon



Sigmoid colon

Arterial Supply: (See the diagram).



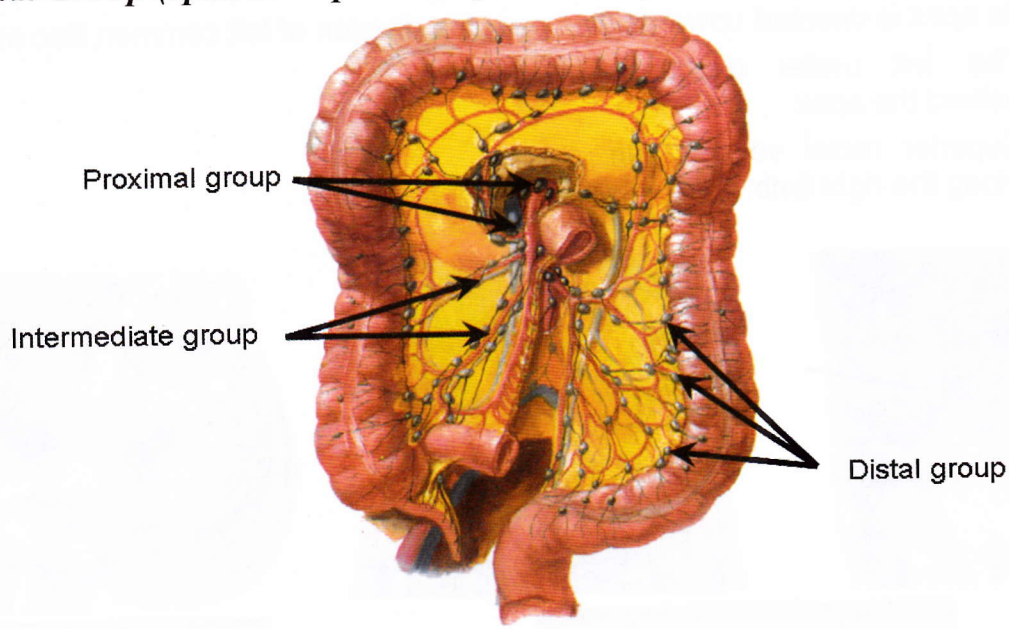
- **MIDGUT**: Superior mesenteric artery
- **HINDGUT**: Inferior mesenteric artery

Lymph Drainage

1- ***Proximal Group:*** situated on the main blood vessels as superior mesenteric, inferior mesenteric, ilio-colic, right colic…etc.

2- ***Intermediate Group:*** along the smaller branches (e.g. ascending & descending branches of right colic).

3- ***Distal Group (epicolic & paracolic):*** near the gut wall.



CAECUM

Site: in the Rt. iliac fossa above the lateral ½ of the inguinal ligament.

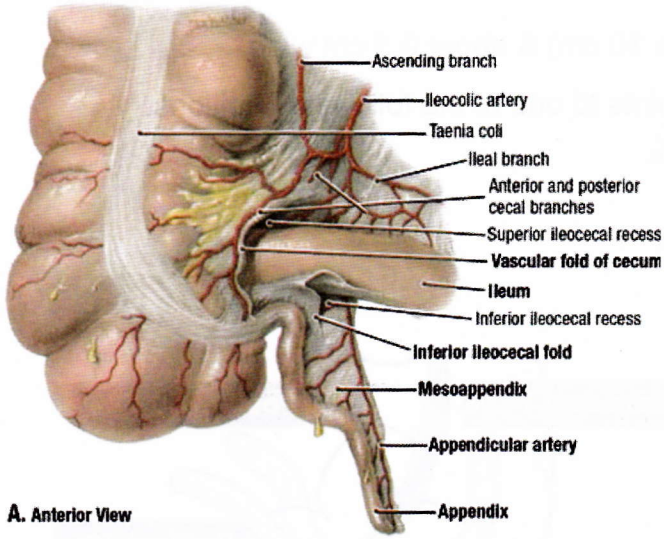
Relations:

- **Anteriorly:** anterior abdominal wall, greater omentum & loops of small intestine.
- **Posteriorly:** retro-caecal recess, Rt. psoas muscle, Rt. iliacus muscle, Rt. femoral nerve, lateral cutaneous nerve of thigh, Rt. gonadal & external iliac vessels.

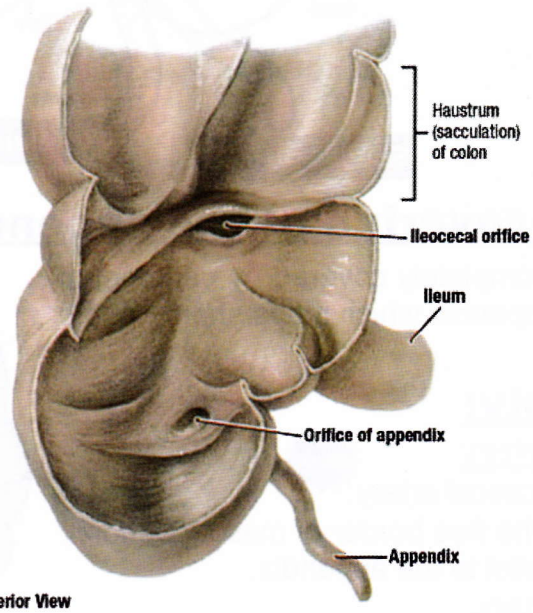
Peritoneal covering: from front and sides.

Special features:

- It has an ileo-caecal orifice opening in its medial wall.
- The appendix attached to its postero-medial aspect.
- It possesses 3 taenia coli that converge on the appendix.



A. Anterior View

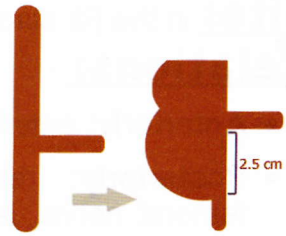


C. Anterior View

APPENDIX

Embryology:

- At first, it has the same caliber as the caecum but there is excessive growth of Rt. side of the caecum.
- Rare sites are: the sub-hepatic type & situs inversus totalis.



Anatomy

Site:

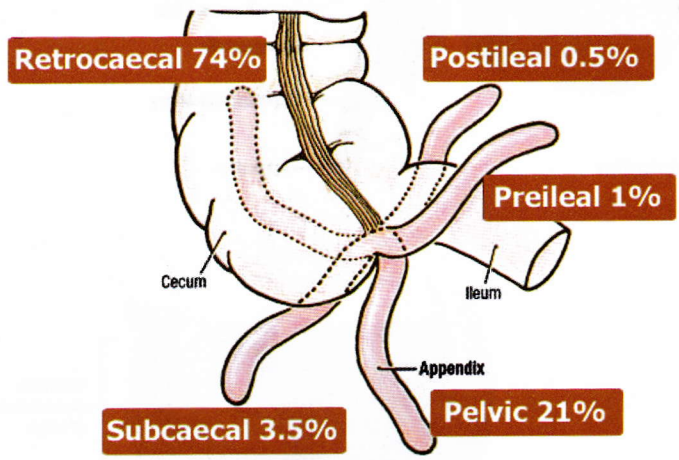
MCQ
- Rt. Iliac fossa (except in sub-hepatic type & situs inversus totalis).
- Attached to the postero-medial aspect of the caecum, 1inch below the ileo-caecal valve (at the meeting of 3 taenia coli).

Size

2-20 cm (average 10 cm) & about 0.5 cm wide

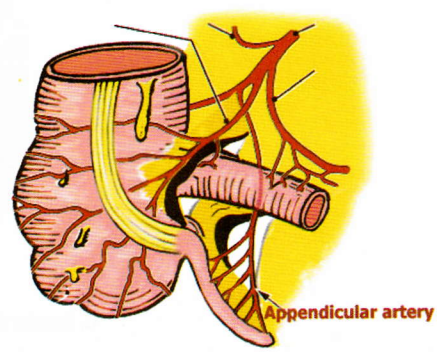
Position: Its tip points to one of the following positions:

MCQ
- Retro-caecal 74%.
- Pelvic 21%.
- Sub-caecal 3.5%.
- Pre-ileal 1%.
- Post-ileal 0.5%.



Peritoneal covering of the appendix

The appendix is completely covered by peritoneum and has a mesoappendix which stops shortly at the tip of appendix.



Blood Supply:

Appendicular artery

MCQ
- From the ilio-caecal artery.
- It runs along the free border of mesoappendix & distally parallel to the appendix.
- It is an end artery.

Surgical Importance:
The inflammatory process causes thrombosis & gangrene of the appendix. It should be noticed that gangrene occurs at the tip because it is far from the blood supply and the peritoneum is deficient over the tip of the appendix.

Appendicular vein

- Drains into superior mesenteric vein → portal circulation.
- **Surgical Importance:** Appendicitis can cause portal pyemia.

Nerve supply

- T_{10} supplies the peritoneal coverings of the appendix, so reffered appendicular pain is felt at the umbilicus.

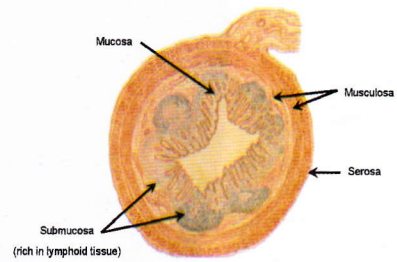
Lymph Drainage

→ Ilio-caecal → superior mesenteric LNs.

Structure

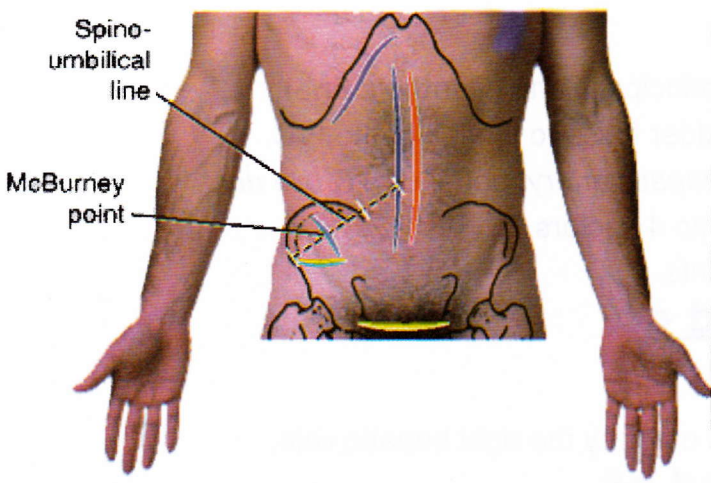
- The wall is composed of mucosa, submucosa, musculosa & serosa.
- Submucosa & musculosa are rich in lymphoid tissue.
- Appendix is the tonsil of GIT and by aging, it atrophies.

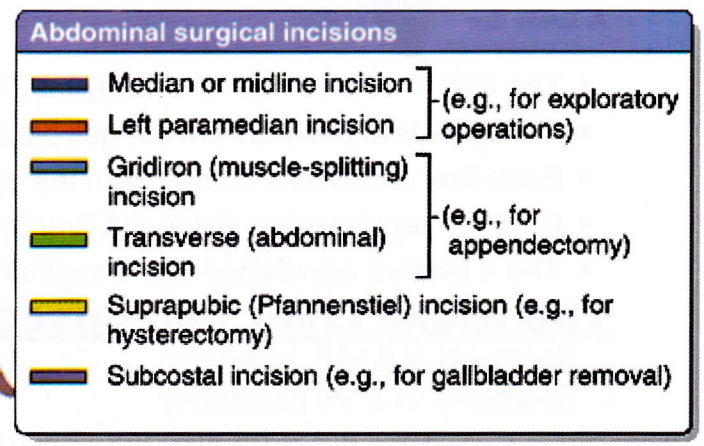
Surgical Importance: cancer caecum should be suspected in any case of acute appendicitis in old age.



Surface anatomy: The base of the appendix (McBurney's point):

At the junction of lateral ⅓ & medial ⅔ of a line extending from ASIS to the umbilicus.





Points of Surgical Importance:

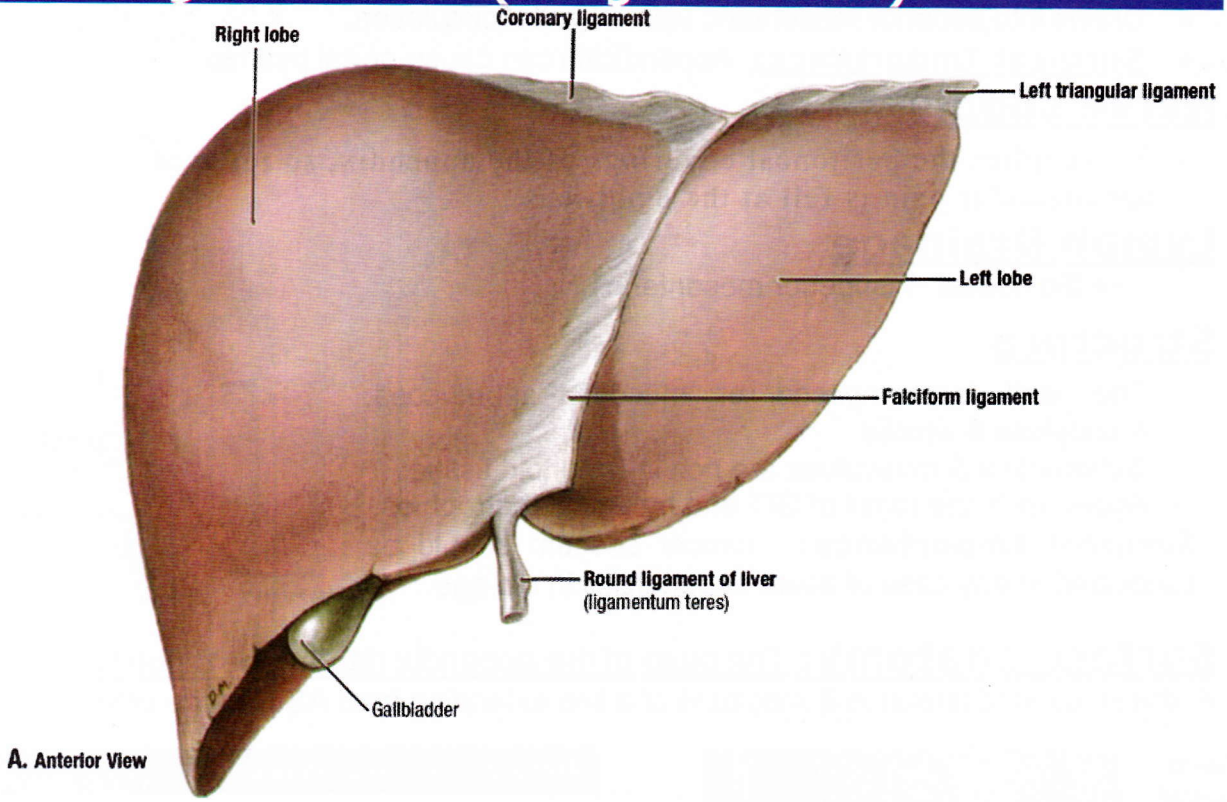
1) **McBurney's** point is the surface anatomy of the ***base of the appendix***. Normally, we open in front of the base & not the apex. This is because the base lies in a fixed position while the apex has different positions.
2) When performing appendicectomy through gridiron incision, you will encounter:

MCQ
a. *Scarpa's fascia* **superficial** to external oblique aponeurosis.
b. *External oblique muscle fibers* **parallel** to the line of incision.
c. *Internal oblique & transversus abdominis* lying almost in a **transverse** direction.
d. *The transversalis fascia* fused with the peritoneum.

MCQ
3) During appendicectomy, we use the **anterior taenia coli** on the caecum as a guide to the appendix.
4) Bleeding during muscle cutting occurs from **deep circumflex iliac vessels.**

THE LIVER

MCQ iver Segmentation (Surgical lobes)



A. Anterior View

- The liver is divided into 2 livers by the principal plane **(Cantlie's line)**.
- **Cantlie's line** passes from the gall bladder fossa to the left of the IVC.
- Each liver receives a branch from the *hepatic artery*, *portal vein* & *bile duct*.
- Rt. & Lt. hepatic veins divide the liver into 4 sectors.
- The 4 sectors are divided into 8 segments.

The Right Liver composed of

- Segments V & VIII, anteriorly
- Segments VI & VII posteriorly

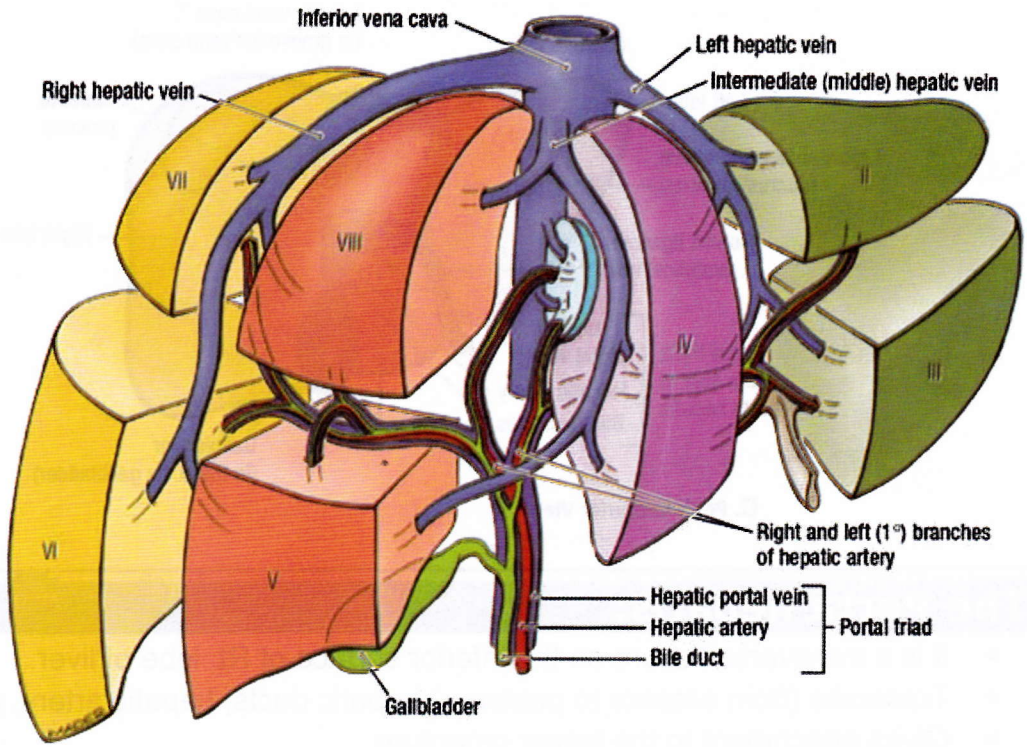
They are separated from each other by the right hepatic vein.

The Left Liver is composed of

- Segment I → caudate lobe.
- Segment IV → quadrate lobe.
- Segment II & III → form the anterior part of the left lobe.

Surgical Importance:

Each segment has its own arterial, portal & hepatic duct branch → can be removed separately (i.e. segmentectomy).



A. Anterior View

Liver Lobation (Anatomical Lobes)

Morphologically divided into Rt. & Lt. lobes by:

1- Falciform ligament: at the anterior surface and superior surface.
2- Fissure of ligamentum teres: at inferior surface.
3- Fissure of ligamentum venosum: at posterior surface.

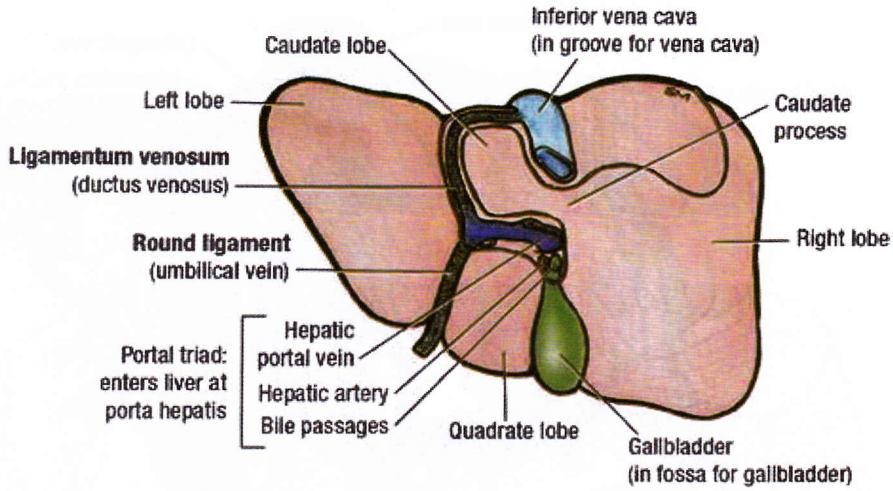
Rt. lobe shows 2 small lobes:

1) Caudate lobe: (on the posterior surface)

MCQ
- Lies between groove of IVC & fissure for ligamentum venosum.
- ***The caudate process:***
  - It is the part of the caudate lobe extending between IVC & porta hepatis.
  - Forms the roof of epiploic foramen.

2) Quadrate lobe: (on the inferior surface) → it is bounded by:

MCQ
- To the left: fissure for ligamentum teres.
- To the right: gallbladder fossa.
- Anteriorly: inferior border of the liver.
- Posteriorly: porta hepatis.



C. Posteroinferior View

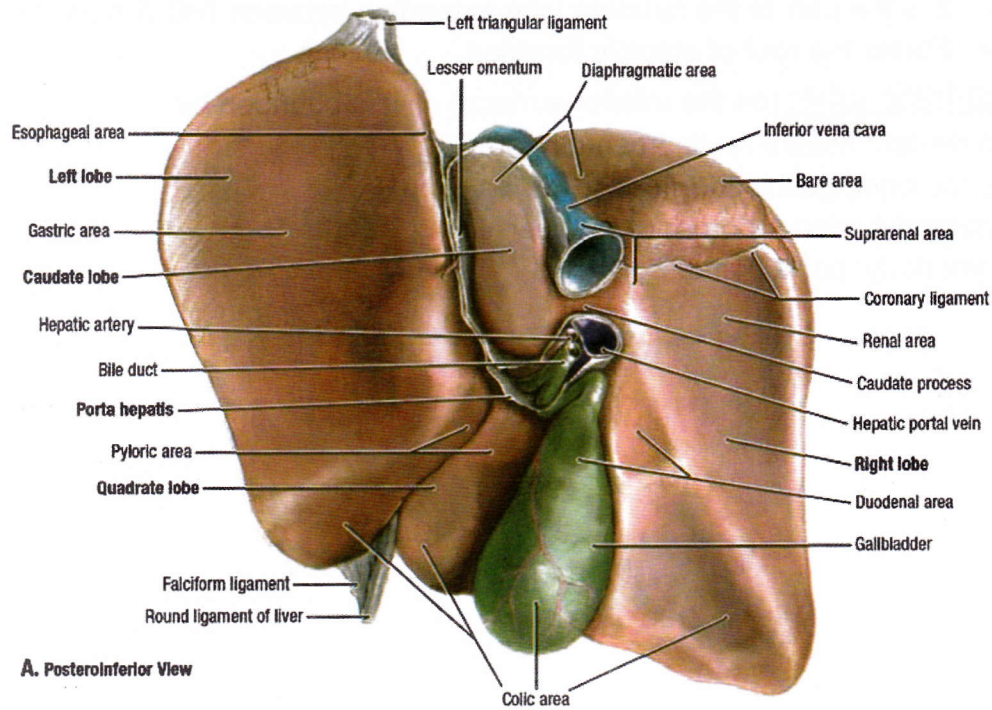
The Porta hepatis: MCQ

- It is a transverse fissure on the inferior surface of Rt. lobe of liver.
- Transmits (from anterior to posterior) hepatic ducts, hepatic artery, portal vein.
- Gives attachment to the lesser omentum.

Shape & Borders: wedge-shaped with ill-defined borders except inferiorly.

Relations:

1. **Superior surface**: related to the diaphragm.
2. **Anterior surface:** related to diaphragm, xiphoid process & ant. abdominal wall.
3. **Right lateral surface:** related to the diaphragm, separating it from Rt. lung, pleura & 6^{th} – 11^{th} ribs.
4. **Inferior (visceral) surface:** abdominal esophagus, stomach, duodenum, lesser omentum, transverse colon, gallbladder, Rt. colic flexure & Rt. Kidney. MCQ



A. Posteroinferior View

Peritoneal Coverings:

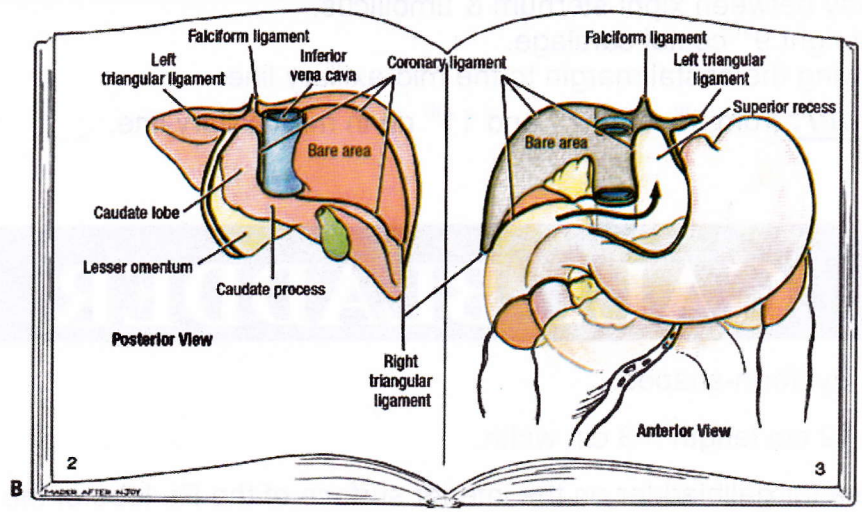
- The liver is completely covered by peritoneum except the following areas:

MCQ

1. Bare area of the liver lies between superior & inferior layers of coronary ligament.
2. Fossa for gall bladder.
3. Groove for IVC.
4. Porta hepatis.

Peritoneal Folds of the liver:

- **Falciform ligament:** to diaphragm & ant. abdominal wall.
- **Lesser omentum:** to stomach & 1st inch of the duodenum.
- **Rt. & Lt. triangular ligaments:** to the diaphragm.
- **Upper & lower coronary ligaments:** to the diaphragm.



N.B: The ligamentum teres is obliterated vestige of Left umbilical vein.

Blood Supply: 70% from portal vein & 30% from hepatic artery.

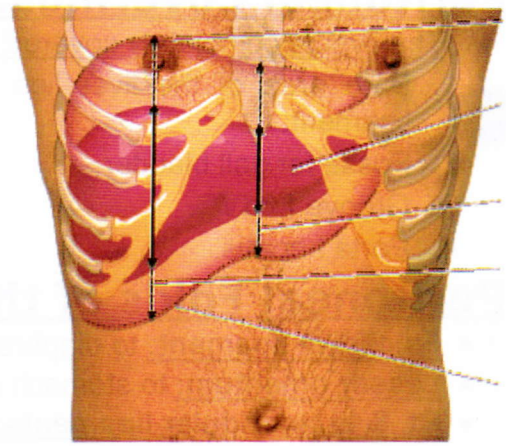
Venous Drainage:

- **Hepatic veins:**
  - 3 veins: Rt. hepatic vein drains into IVC while middle & left hepatic veins unite and drain into IVC.
  - Emerge from the back of the liver & drain into the IVC.
- **Caudate lobe drains directly into the IVC by multiple small veins.**

Lymphatic drainage of liver:

- Lymphatics of the posterior part of the liver follows the IVC to end in the diaphragmatic LNs around the upper end of IVC.
- Lymphatics of the remaining parts of the liver follows the hepatic artery to end in the celiac LNs.

Surface Anatomy



Upper Border: **represented by a line joining the following points:**

1- Apex of the heart.
2- A point at the xiphi-sternum.
3- 5th rib in right mid-clavicular line.
4- 7th rib in the right mid-axillary line.
5- 9th rib in right scapular line.

Lower Border: **marked by a line joining the following points:**

1- A point on the Lt 5th intercostal space at the Lt. lateral vertical plane.
2- A point on the lt. costal margin at the tip of the 8th costal cartilage.
3- Midway between xiphi-sternum & umbilicus.
4- Tip of right 9th costal cartilage.
5- Following the costal margin to the mid-axillary line.

Right border: from 5th rib to 7th and 11th rib in mid-axillary line.

GALL BLADDER

Shape: Pyriform-shaped.

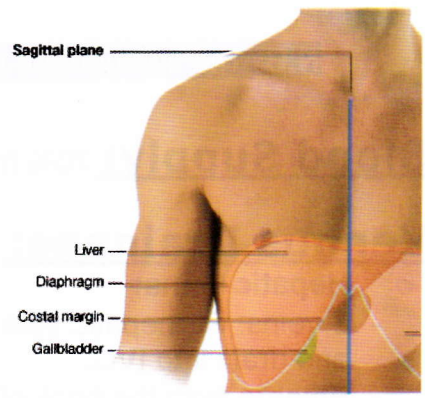
Size: 8 - 12 cm length × 3 cm width.

Site: fossa for gallbladder on the inferior surface of the Rt. lobe of the liver.

Capacity: 30-50 ml

Power of Concentration: 10 times

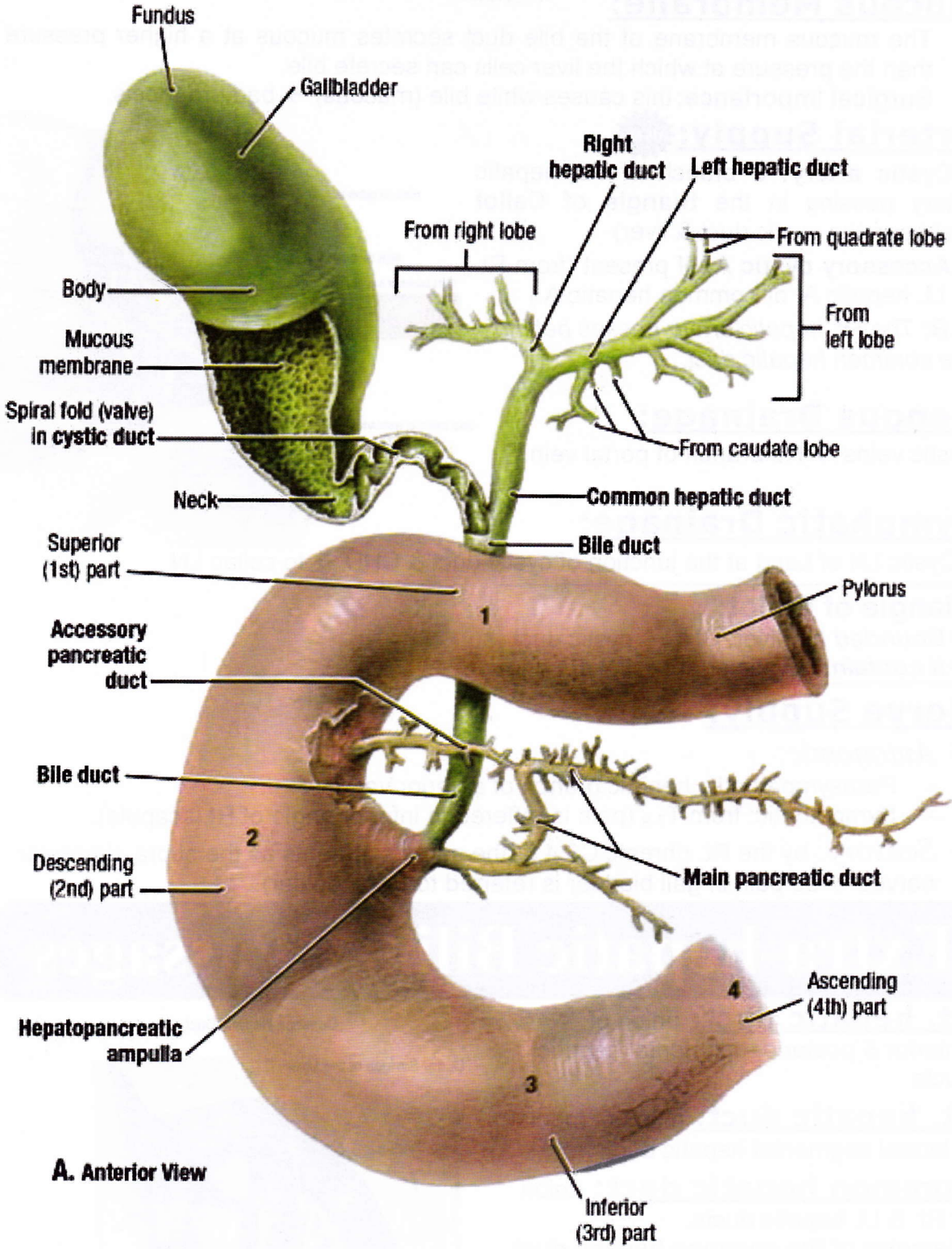
Parts:



A. Fundus:

- Projects beyond the inferior border of the liver.
- Is covered by peritoneum all around.
- Related to:
  - *Anteriorly*: anterior abdominal wall.
  - *Posteriorly*: transverse colon.

Surface anatomy: at junction between Rt. linea semilunaris and Rt. costal margin (tip of Rt. 9th costal cartilage).



B. Body:

- In contact with gall bladder fossa of liver, to the right side of the quadrate lobe.
- Its inferior surface is covered by peritoneum.
- **Related to:** 1st part of the duodenum.

C. Neck:

- U-shaped.
- Mucosa projects into the lumen forming ***valve of Heister*** (mainly in cystic duct).
- When dilated → Hartmann's pouch.

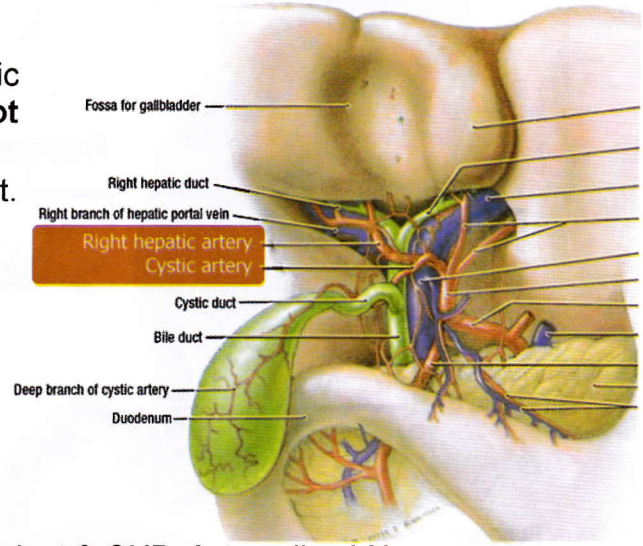
Mucous Membrane:

- The mucous membrane of the bile duct secretes mucous at a higher pressure than the pressure at which the liver cells can secrete bile.
- **Surgical Importance:** this causes white bile (mucous) → bad prognosis.

Arterial Supply: MCQ

- **Cystic artery:** a branch of Rt. hepatic artery passing in the **triangle of Callot** (between the cystic duct & liver)
- **Accessory cystic A.:** if present (from Rt. or Lt. hepatic A. or common hepatic A.)

N.B: *The Rt. hepatic artery passes behind the common hepatic duct.*



Venous Drainage:

cystic veins → Rt. branch of portal vein.

Lymphatic Drainage:

- Cystic LN of Lund at the junction of cystic duct & CHD → to celiac LN

Triangle of Callot:

- ***Bounded by:*** liver, CHD & cystic duct
- ***It contains:*** cystic artery & LN of Lund

Nerve Supply:

- *Autonomic:*
  - Parasympathetic: hepatic branch of anterior vagus.
  - Sympathetic: from T_{7-9} (pain is reffered to inferior angle of Rt. scapula).
- *Sensory:* by the Rt. phrenic C3,4,5 (the same segments as the supra-clavicular nerves → so pain in gall bladder is referred to Rt. shoulder).

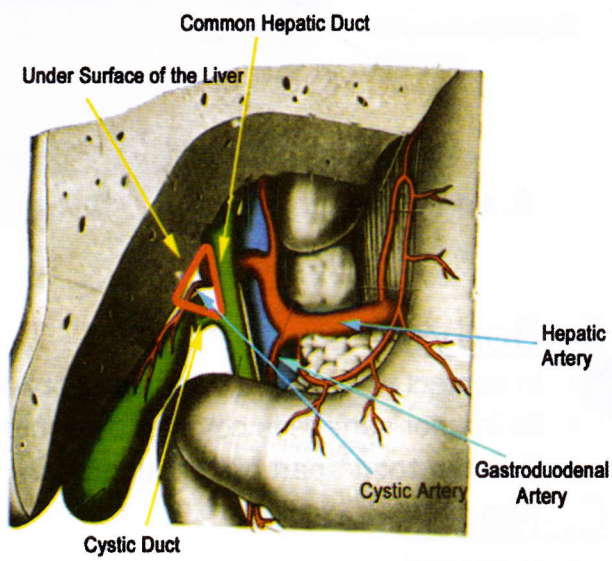
Extra-hepatic Biliary Passages

Rt. hepatic duct: union of anterior & posterior segmental hepatic ducts.

Lt. hepatic duct: union of medial & lateral segmental hepatic ducts.

Common hepatic duct: union of Rt. & Lt. hepatic ducts.

Diameter of the common hepatic duct is 4 mm by U/S



Cystic duct:

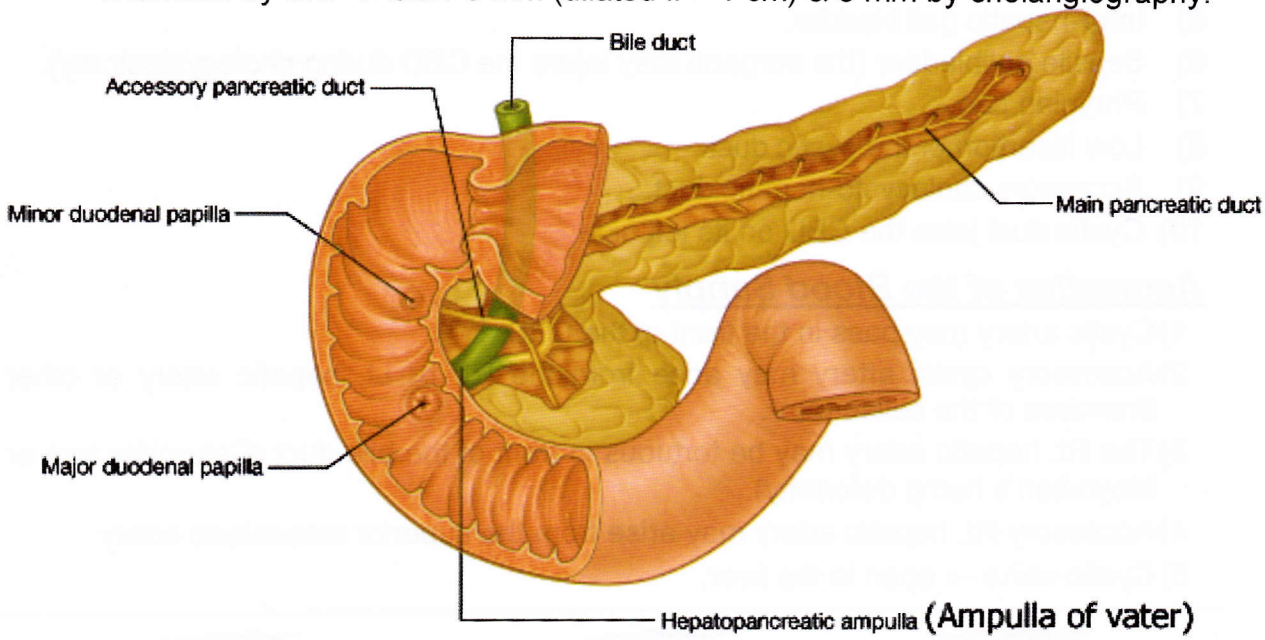
MCQ

- S-shaped, 2.5 cm, its mucosa contains crypts of Luschka.
- Has a spiral valve in its interior of Heister.
- Allows bile to flow to & from the GB.
- Usually joins the common hepatic duct on its Rt. side.

N.B: The Rt. hepatic duct rarely enters the gallbladder near its junction with the cystic duct

The common bile duct: MCQ

- Formed by union of common hepatic duct & cystic duct.
- It is divided into 4 parts & its length is 3 - 4 inches.
- Its length inversely proportional to the length of the hepatic duct.
- Diameter by U/S → CBD 6 mm (dilated if > 1 cm) & 8 mm by cholangiography.



A. Supra-duodenal Part

- It is formed by union of cystic duct & common hepatic duct (Y-shaped).
- It runs downwards in the free border of the lesser omentum.
- The portal vein lies behind it while the hepatic artery lies on its left side.
- It is separated from IVC by foramen of Winslow.
- **The wall of the supra-duodenal part has a venous plexus which can be seen at operation.**

B. Retro-duodenal Portion

- It is behind the 1st part of duodenum.
- On its left side lies the gastro-duodenal artery; and the portal vein behind them.

C. Infra-duodenal Portion

- Behind the head of pancreas (cancer head of pancreas → obstructive jaundice).

D. Termination of the CBD (Intra-duodenal portion)

MCQ

a. Either unites with the main pancreatic duct to form hepato-pancreatic duct which ends in the ampulla of Vater (present in the postero-medial part of the middle of the 2nd part of the duodenum 10 cm beyond the pylorus).

b. Or common bile duct and main pancreatic duct open separately at ampulla of Vater (it may terminate without ampulla).

The duodenal papillae permit passage of dilator 3 mm in diameter.

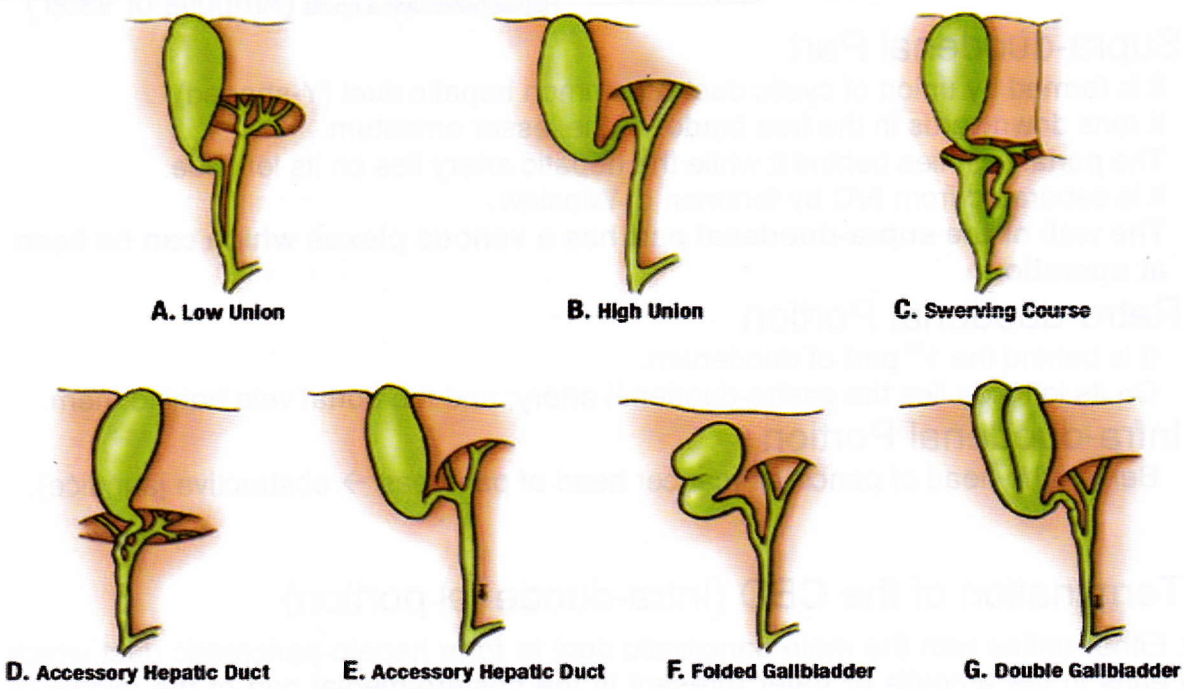
Congenital Anomalies

Anomalies of the Gall Bladder:

1) Congenital absence.
2) Septate.
3) Double gallbladder with single duct or double ducts.
4) Floating gall bladder.
5) Intra-hepatic gall bladder.
6) Sessile gallbladder (the surgeon may injure the CBD during cholecystectomy).
7) Phrygian cap.
8) Low insertion of the cystic duct.
9) Accessory cholecysto-hepatic duct.
10) Cystic duct joins the CBD on its left side.

Anomalies of the Blood Supply

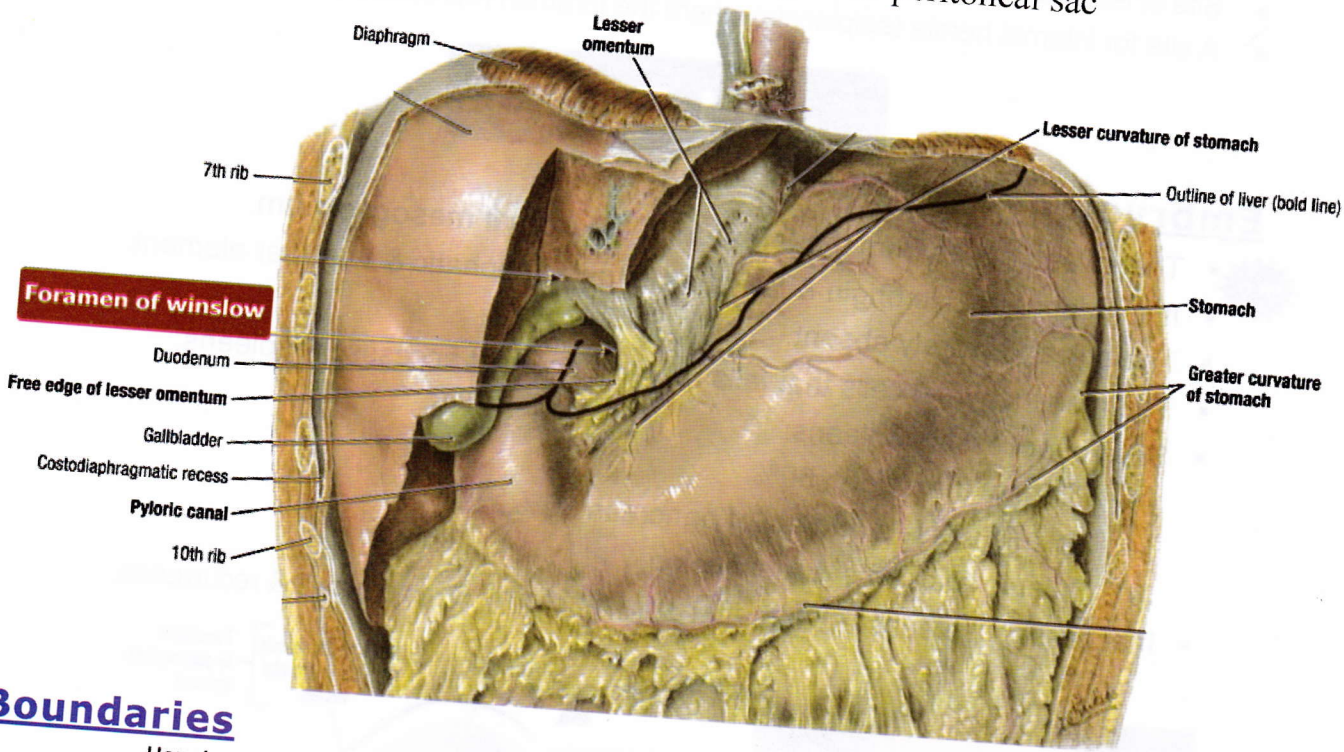
1) Cystic artery may pass in the front of the CBD.
2) Accessory cystic artery may arise from the Rt. or Lt. hepatic artery or other branches of the celiac trunk.
3) The Rt. hepatic artery may be tortuous in front of the bile duct (Caterpillar turn or Moynihan's hump deformity).
4) Accessory Rt. hepatic artery may arise from the superior mesenteric artery.
5) Cystic veins → open in the liver.



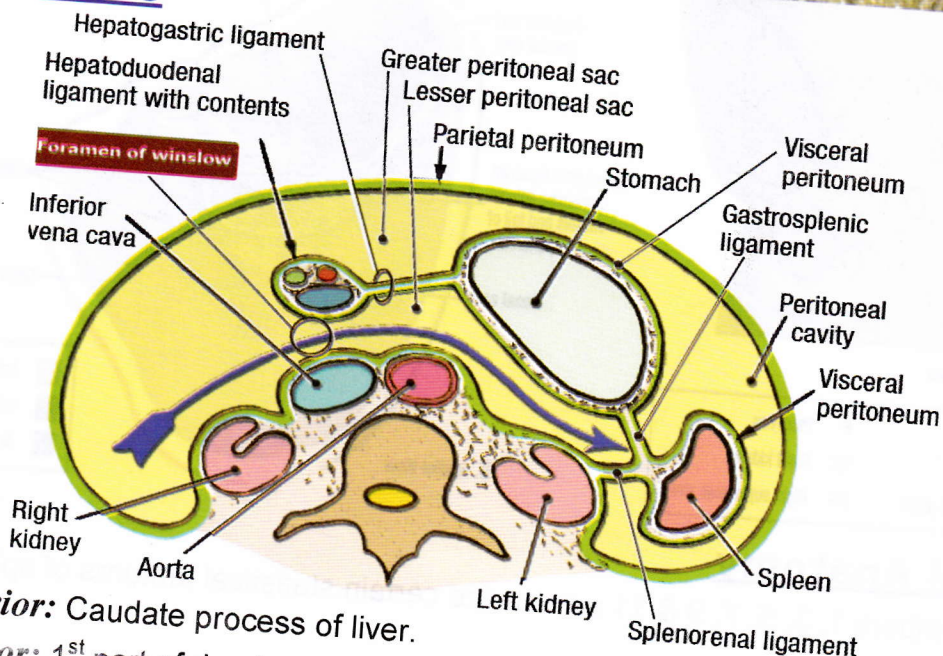
Foramen of Winslow (Opening of the lesser sac)

MCQ

Communicates lesser peritoneal sac to greater peritoneal sac



Boundaries



- ***Superior:*** Caudate process of liver.
- ***Inferior:*** 1st part of duodenum.
- ***Posterior:*** IVC.
- ***Anterior:*** Free border of lesser omentum, <u>containing:</u>
  - Portal Vein: posterior.
  - CBD: anterior & to the right.
  - Hepatic artery: anterior & to the left.

Surgical Importance

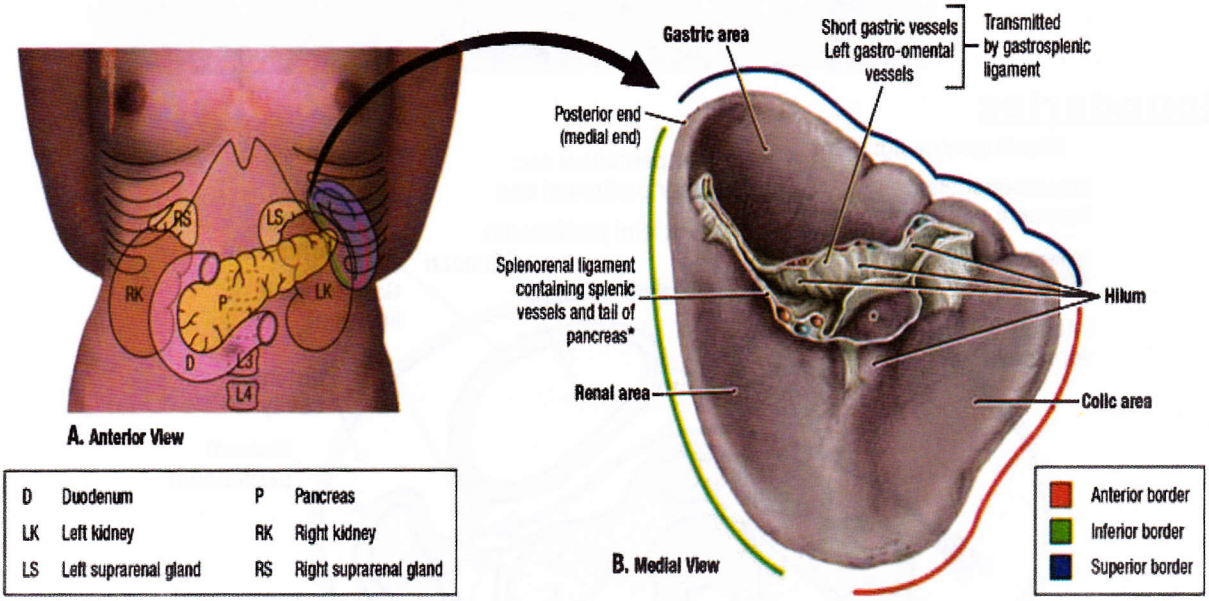
- Site of Porto-caval anastomosis.
- During cholecystectomy, control of bleeding from cystic artery is achieved by **Pringles maneuver** → put the index finger of the Lt. hand in the foramen of Winslow & compress the free border of lesser omentum against the thumb → compression of hepatic artery.
- Site of exposure of supra-duodenal portion of CBD for removal of stones.
- A site for internal hernia (epiplocele) where the foramen represents the defect.

SPLEEN

Embryology

MCQ

- The spleen arises from the **left side** of the **dorsal mesogastrium**.
- It is mesodermal in origin & later has its own lymphatic & vascular element.
- The spleen is rarely absent.
- The mesenchymal cells that fails to fuse becomes accesssory spleens.
- Sites of accessory spleens:
  - Hilum of the spleen 50%.
  - Splenic vessels and tail of pancreas 30%.
  - Splenic ligaments & mesocolon.
- If accessory spleens are left after spleenectomy →hyperplasia & recurrence.



D	Duodenum	P	Pancreas
LK	Left kidney	RK	Right kidney
LS	Left suprarenal gland	RS	Right suprarenal gland

Surgical Anatomy

The odd numbers 1, 3, 5, 7, 9 & 11 summarize certain statistical features of spleen.

Size: 1 X 3 X 5 inches

Weight: 7 ounces (150-200 gm)

Site:

MCQ

- Lt. hypochondrium opposite to the 9th, 10th & 11th ribs with its long axis parallel to 10th rib.
- It normally does not descend below the costal margin.

Shape

It has 2 ends, 2 borders & 2 surfaces

- Ends: (LaMp)
  - **Lateral (anterior) end:** broad, at mid-axillary line.
  - **Medial (posterior) end:** tapering, 4 cm from T10.
- Borders:
  - **Superior border:** sharp & usually has a notch.
  - **Inferior border:** rounded & smooth.
- Surfaces:
  1. ***Diaphragmatic*:** related to the diaphragm.
  2. ***Visceral*:** has 4 impressions & the hilum:

Gastric impression:

- Between the hilum & the upper border.
- It is related to the fundus of the stomach.

Pancreatic Impression:

- Just below the hilum.
- It is related to the tail of pancreas.

Renal Impression:

- Between the hilum & lower border.
- It is related to the front of the Lt. kidney.

Colic Impression

- Close to the anterior end of the spleen.
- It is related to Lt. colic flexure.

Peritoneal coverings:

- It is completely covered with peritoneum.

Ligaments

Gastro-splenic ligament

- It is attached to the anterior margin of the hilum & transmits short gastric vessels and gastro-epiploic vessels.
- It is a part of greater omentum.
- It can be divided easily as it has no important contents.

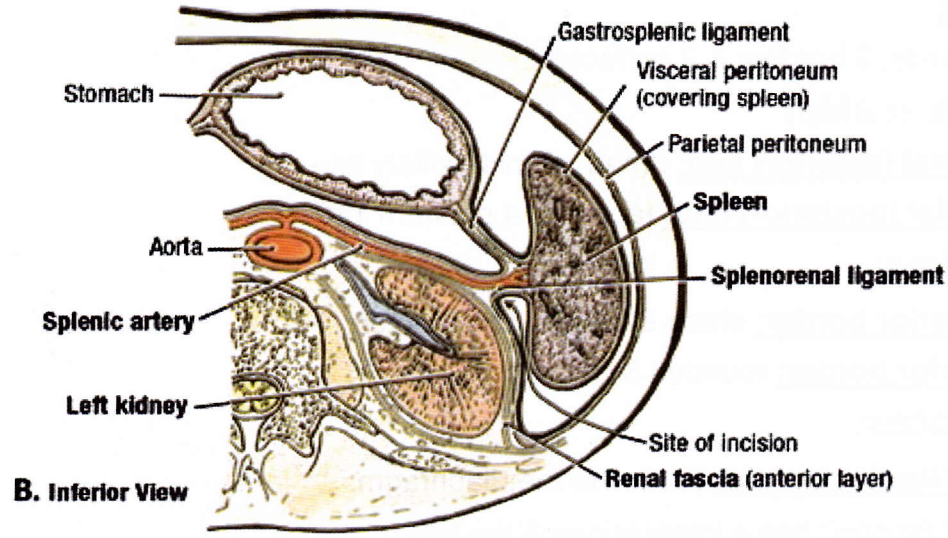
Lieno-renal ligament

- Attached to the posterior margin of the hilum & tail of pancreas & transmits the splenic vessels, nerves & lymphatics.
- Difficult to be cut as it contains important structures.

Phrenico-colic ligament

MCQ

- From splenic flexure of the colon to peritoneum over the kidney.
- Spleen is in contact with it, but not attached to it.
- It is a derivative of the dorsal mesogastrium.



Blood Supply

1) *Splenic artery:* MCQ

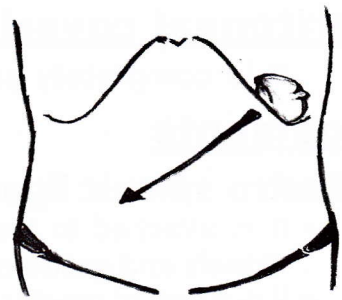
- It is a branch of the **celiac trunk**.
- **Course:**
  - Tortuous course.
  - Along upper border of pancreas (retro-peritoneal).
  - Then reaches the spleen through lieno-renal ligament.

It has 2 or 3 terminal branches not communicating in the spleen. Therefore, segmental resection of the spleen is possible.

2) ***Splenic vein*** → receives the inferior mesenteric vein → then unites with the superior mesenteric vein to form the portal vein.

Lymph Drainage: To the aortic LNs around the celiac trunk.

Growth



1- The **phrenico-colic ligament** is responsible for growth of the spleen to the Rt. iliac fossa.

2- Spleen can grow towards the Lt. iliac fossa when the phrenico-colic ligament is infiltrated in chronic myeloid leukemia or if the ligament is surgically divided.

Surface anatomy:

- Draw 2 transverse lines at 9^{th} & 11^{th} ribs.
- Draw 2 vertical lines at midaxillary line & scapular line from inferior angle of the scapula.

PANCREAS

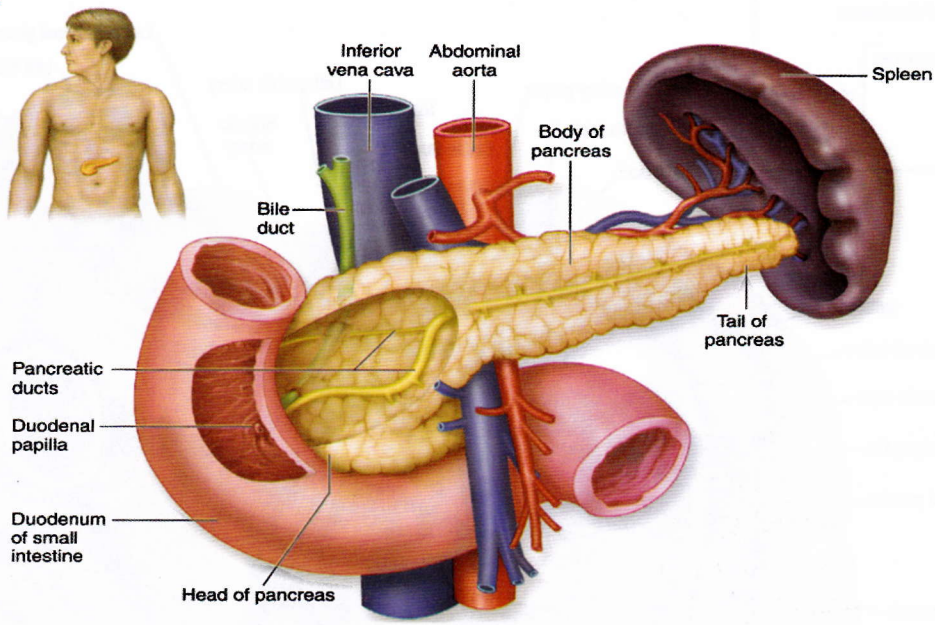
Embryology: It develops from ventral & dorsal buds. MCQ

Anatomy:

- *It is a retroperitoneal organ.*
- It lies obliquely across the upper part of the posterior abdominal wall extending from the duodenal curve to the hilum of the spleen.

Parts:

MCQ



Head:

- Lies within the concavity of the duodenum.
- It has a hook-like process called uncinate process, which projects upwards & to the left.

Relations:

Posterior:

- The CBD passes behind it close to the duodenum.
- The IVC & aorta posterior to it.

Anterior:

- Transverse colon & jejunum.
- The uncinate process is related anteriorly to superior mesenteric artery.

Surgical Importance:

Cancer head of Pancreas may by fatal if infiltration of IVC & aorta occurs.
Cancer head of pancreas → obstructive jaundice.

Neck

- ***Anterior Relations:*** Pyloro-duodenal junction.
- ***Posterior Relations:*** Junction between SMV & splenic v. to form the portal vein.

Body

- ***Anterior:*** the stomach, separated from it by the lesser sac.
- ***Posterior:***
  - The splenic artery runs along its upper border while the splenic vein runs behind it.
  - It crosses in front of the left kidney.

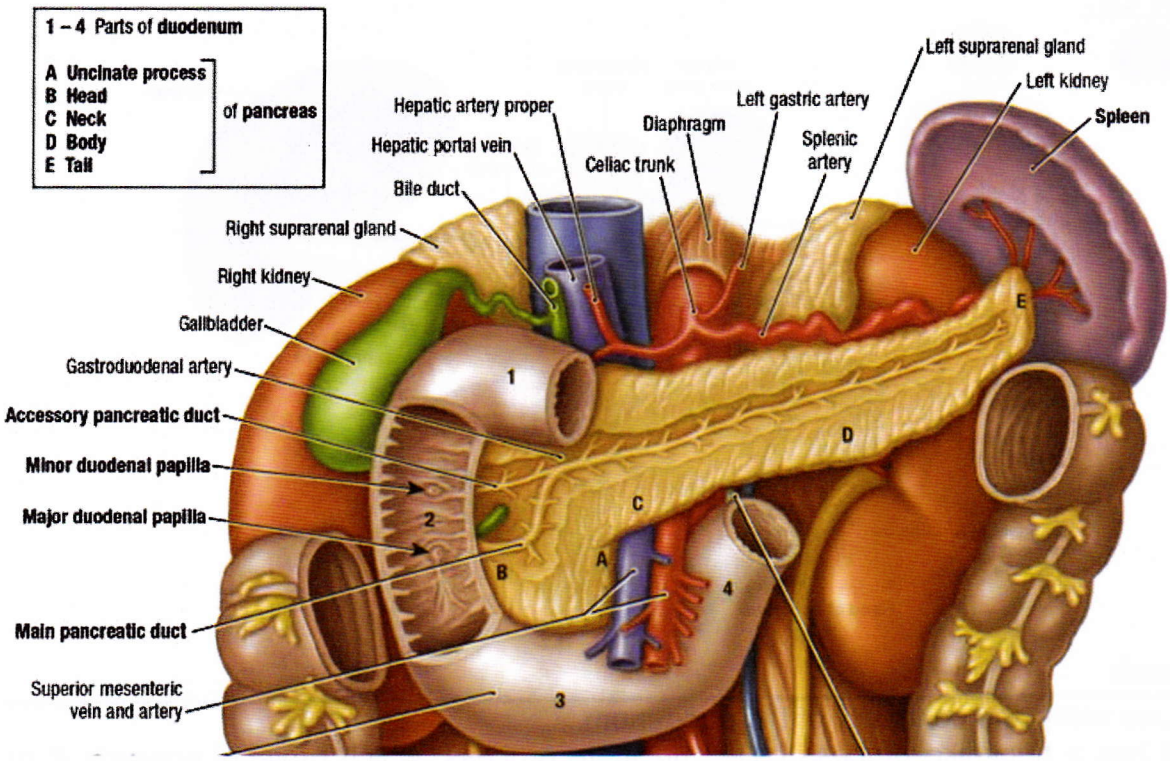
Surgical Importance: the splenic vein is behind pancreas, so at modified Warren operation ligation of the vein is difficult.

Tail

It lies in contact with the hilum of the spleen; in the lieno-renal ligament.

Surgical Importance:

Tail is in the splenic ligament → at splenectomy, injury of the tail leads to burst abdomen.



Ducts of the Pancreas

Main pancreatic duct of Wirsung

- It traverses the whole length of the gland & ends by joining the CBD at the ampulla of Vater & discharges its contents through the major duodenal papilla.
- It represents the duct of the ventral pancreatic bud proximally & the duct of the dorsal pancreatic bud distally.

Accessory pancreatic duct of Santorini

- Usually joins the main pancreatic duct, rarely it becomes the main duct & opens into the duodenum through the superior papilla.

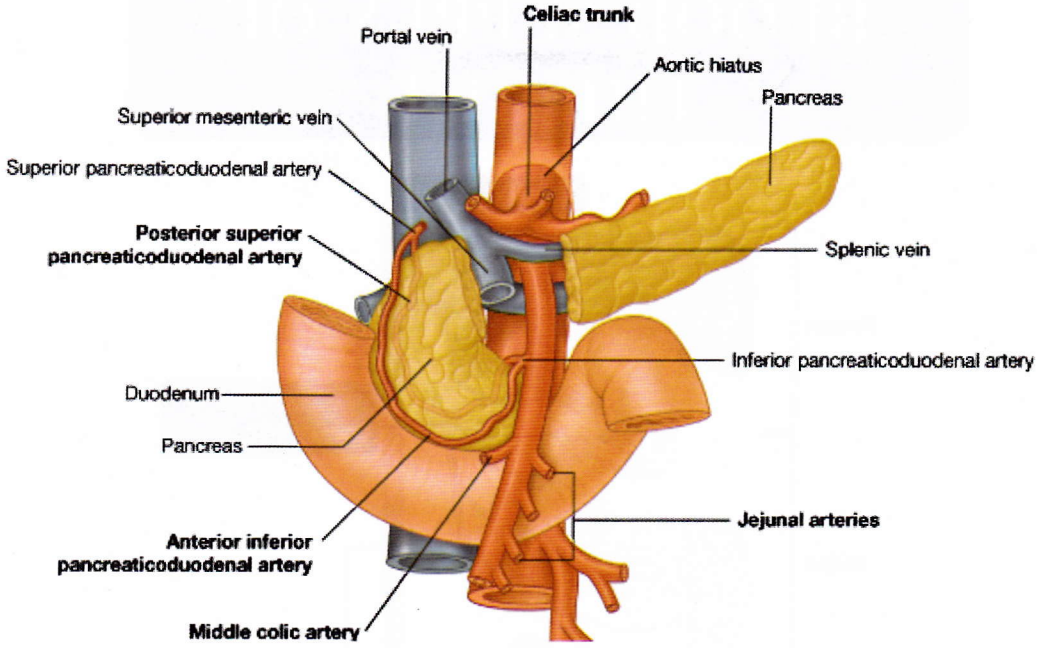
Blood Supply

MCQ

- ***Superior pancreatico-duodenal artery:*** from the gastro-duodenal artery.
- ***Inferior pancreatico-duodenal artery:*** from the superior mesenteric artery.
  - → Both of them supply the head & the duodenum.
- The rest is supplied by branches of splenic & superior mesenteric arteries.

N.B: *The pancreatica magna artery arises from the splenic artery.*

Surgical Importance: at Whipple's operation, both pancreas & duodenum are removed.

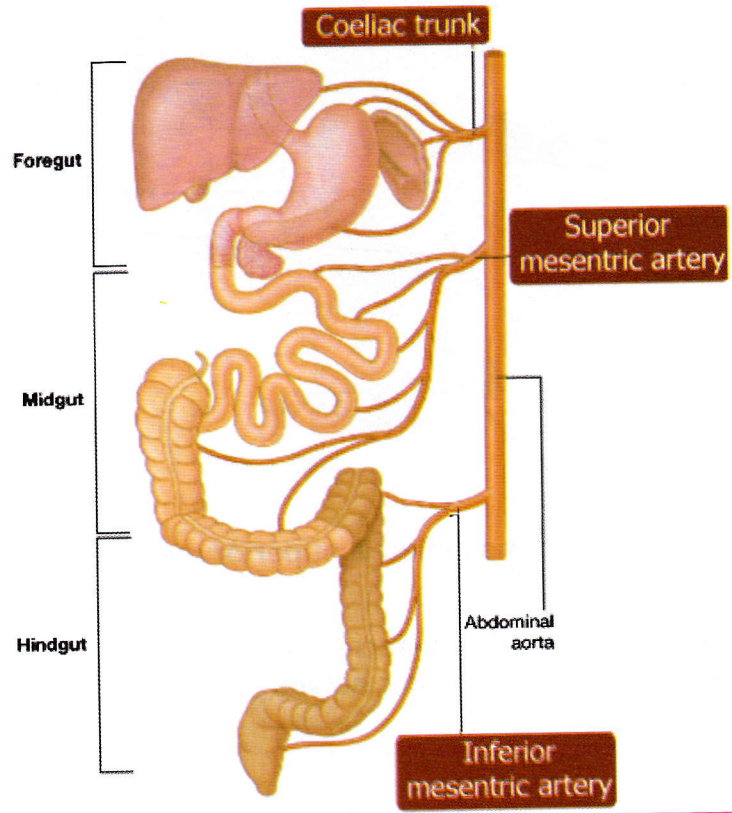


Lymph Drainage: To the celiac & superior mesenteric LNs.

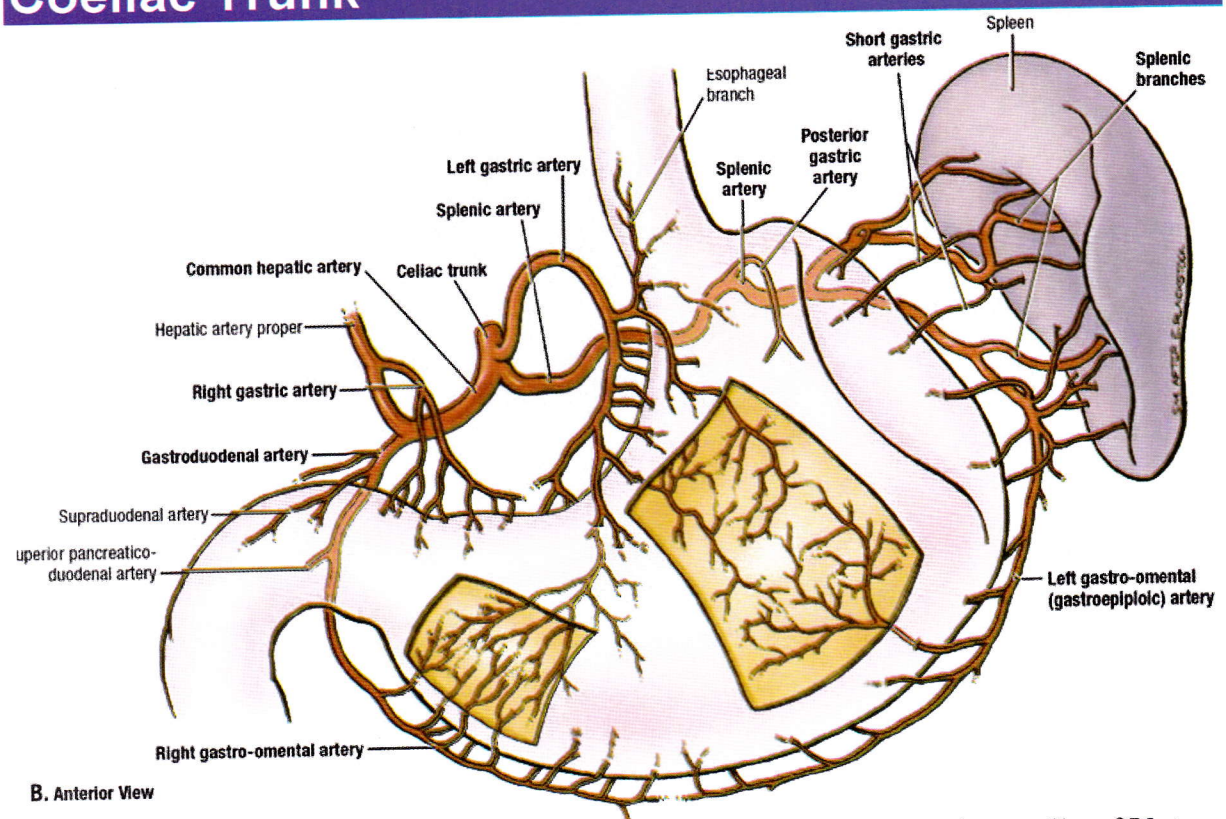
Nerve Supply:

- ***Parasympathetic:*** From the vagus (secretory).
- ***Sympathetic***: From greater splanchnic nerves (it is concerned with pain).

BLOOD SUPPLY OF THE GUT

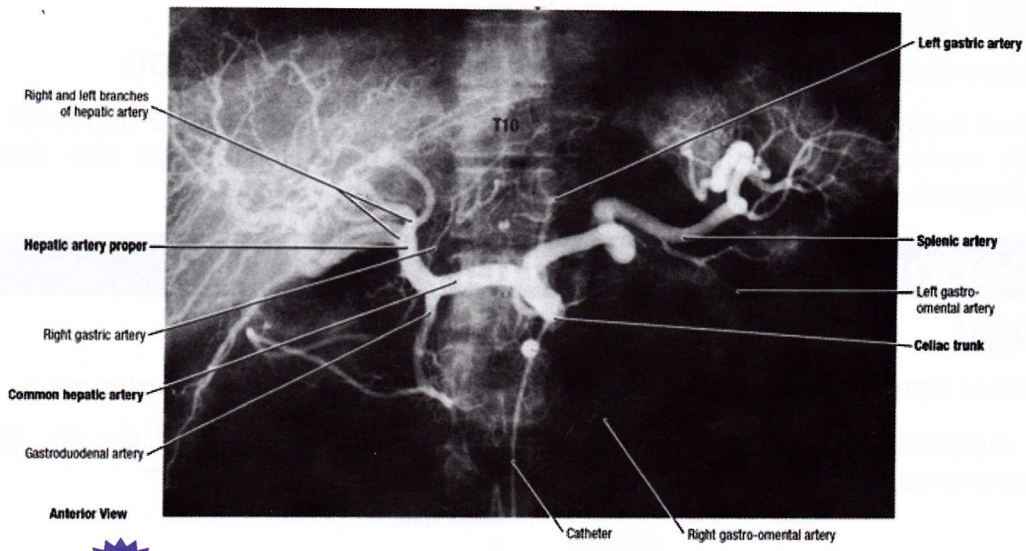


Coeliac Trunk



B. Anterior View

- It is the artery of forgut. It supplies the gut above the level of ampulla of Vater.



Origin: MCQ

- It arises from the abdominal aorta at the level of **upper border of L1**.
- It supplies the **foregut** above the level of ampulla of Vater.
- **Related to celiac ganglion on either side.**

Branches MCQ

1. ***Left gastric artery.***

- It runs upward & to Lt. toward the cardia.
- Its branches include:

  a- Esophageal branches.

  b- Gastric branches.

2. ***Splenic artery:***

- It runs along the superior border of pancreas & enters the lineorenal lig.
- Its branches include:

  a- To pancreas: pancreatic branches to supply its body & tail.

  b- To stomach:

  - *Short gastric arteries:* pass in gastro-splenic ligament.
  - *Lt. gastro-epiploic:* supply Lt. part of greater curvature.
  - *Posterior gastric* in 50%.

  c- Terminal branches: to spleen.

3. ***Hepatic artery:*** Its branches include:

a- **Rt. gastric** along the lesser curvature of the stomach.

b- **Gastro-duodenal** artery which gives: MCQ

i- *Rt. Gastro-epiploic:* along greater curvature of the stomach.

ii- *Superior pancreatico-duodenal:* anastomoses with inferior pancreatico-duodenal between the head of pancreas & 2nd part of duodenum.

c- **Supra-duodenal artery.**

d- **Left hepatic artery.**

MCQ e- **Right hepatic artery:** gives *cystic artery* to the gall bladder.

Points of Surgical Importance

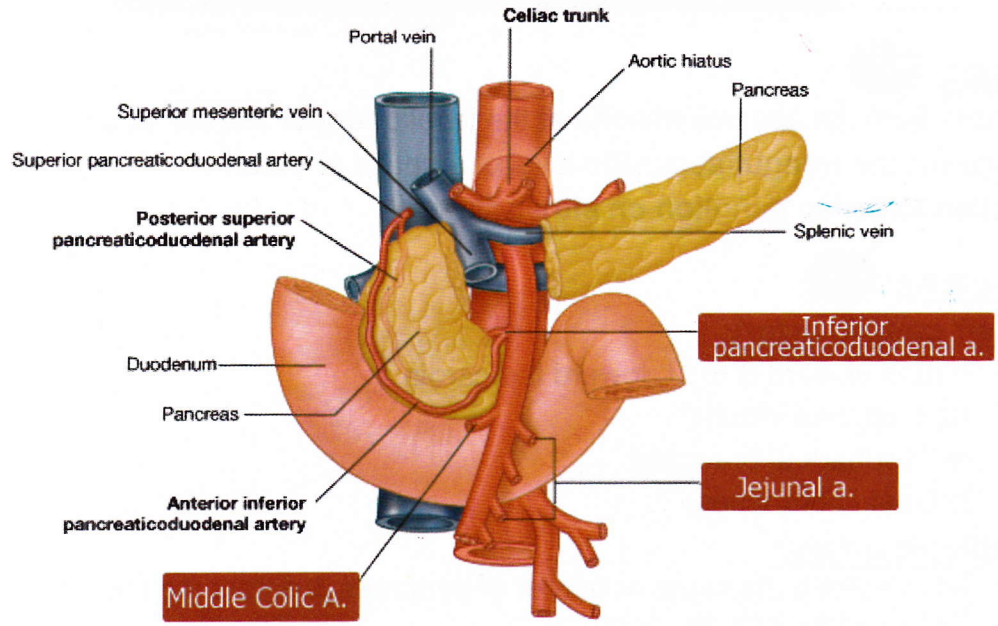
- Gastro-duodenal artery may cause fatal bleeding in perforated DU.
- Blood supply of duodenum & pancreas is the same (pancreatico-duodenal a.), so, with removal of the head of pancreas we have to remove the duodenum (Whipple's operation).

Superior Mesenteric Artery

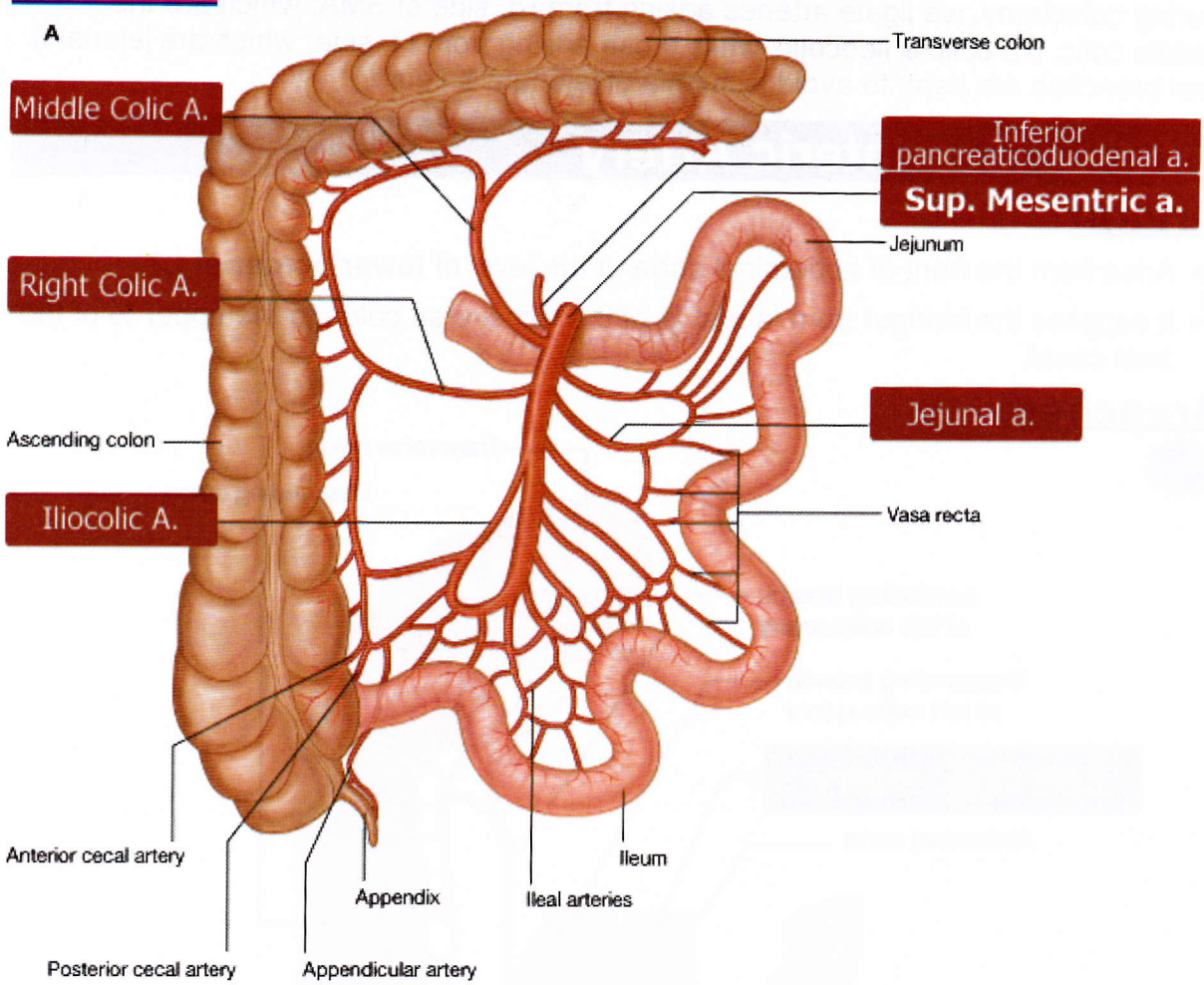
Origin:

- Arises from the front of abdominal aorta at the level of lower border of L1.
- It supplies the midgut from the level of ampulla of Vater till the Rt. ⅔ of the transverse colon.

MCQ



Branches



1. **Inferior pancreaticoduodenal artery**

   It anastomoses with the superior pancreatico-duodenal artery between the head of pancreas & 2nd part of the duodenum.

2. **Jejunal & ileal branches (12- 15)**
   - It forms the arterial arcades in the mesentery.
   - The arcades are simple in jejunum & complex in ileum.

3. **Ileo-colic Artery:** it is the continuation of the SMA.
   - Branches:
     1. Ileal branches.
     2. Appendicular branches (the continuation of the ileo-colic a.).
     3. Anterior caecal & posterior caecal branches to the caecum.
     4. Ascending branches anastomose with the descending branches of the Rt. colic.

4. **Right Colic Artery:** Its branches include:
   1. Descending branches anastomose with ascending branch of ileocolic.
   2. Ascending branches anastomose with the Rt. branches of the middle colic a.

5. **Middle Colic Artery:** Its branches include:
   1. Rt. branch anastomoses with ascending branches of Rt. colic.
   2. Lt. branch anastomoses with ascending branches of superior Lt. colic artery.

MCQ ***N.B:*** *Superior mesenteric artery lies on the Lt. side of superior mesenteric vein*

Surgical Importance

During colectomy, we ligate arteries arising from Rt. side of SMA; which are the middle colic, Rt. colic & ileocolic, while those arising from Lt. side; which are jejunal & ileal branches are kept; to avoid ischemia of jejunum & ileum.

Inferior Mesenteric Artery

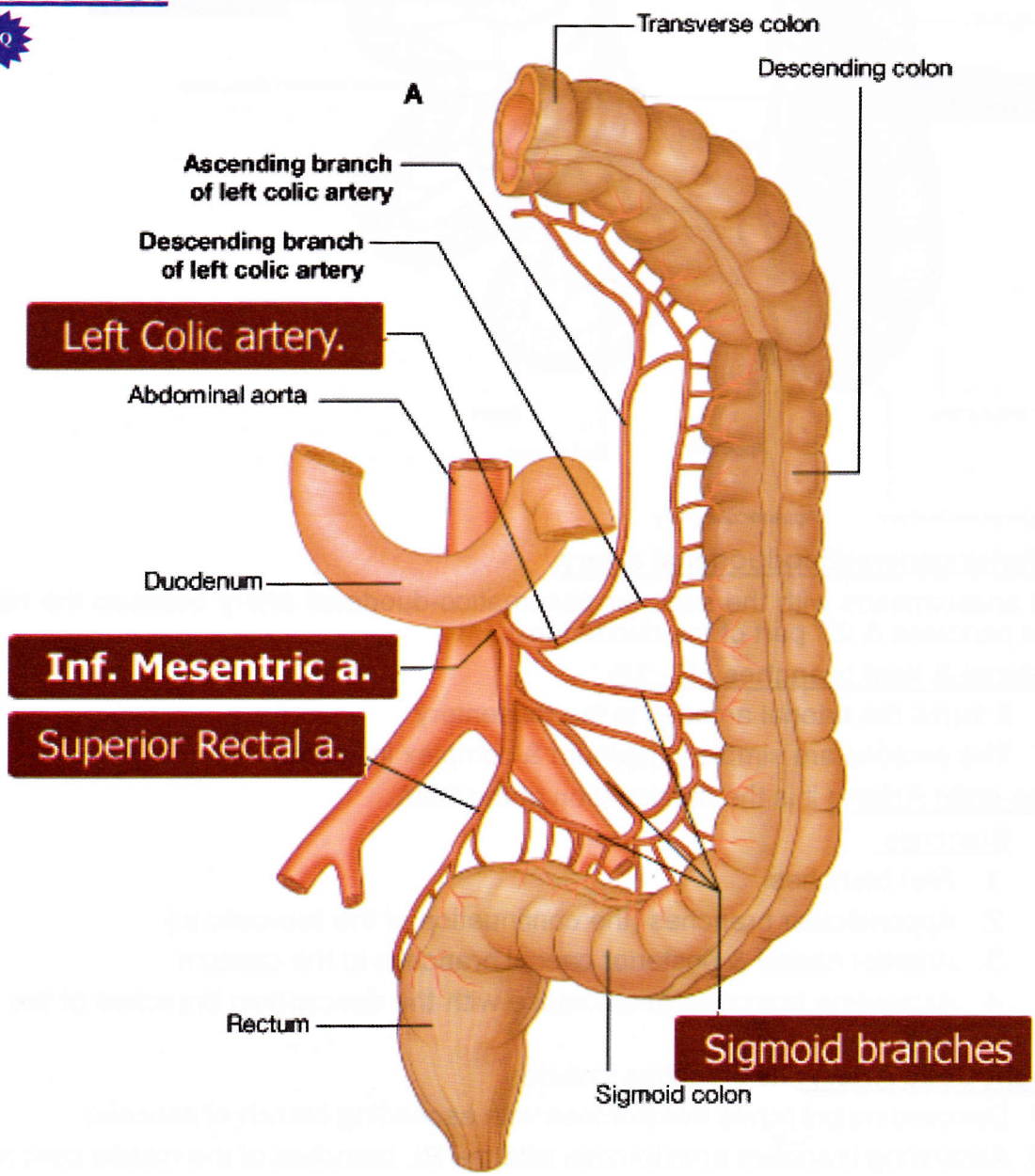
Origin:

MCQ

- Arise from the front of abdominal aorta at the level of **lower border of L3.**
- It supplies the hindgut from lateral ⅓ of the transverse colon to the upper ½ of the anal canal.

Branches:

MCQ



1- **Left Colic artery:** Its branches include:
   a- Ascending branches anastomose with the Lt. branches of the middle colic.
   b- Descending branches anastomose with sigmoid branches.

2- **Sigmoid branches.**

3- Superior Rectal artery:

- It supplies the rectum & upper 1/2 of anal canal.
- it is a continuation of the inferior mesenteric artery & anastomoses with the middle & inferior rectal arteries.

Marginal artery (Drummond's arch):

- It is continuous arterial arcades along the concavity of the colon.
- It is formed by anastomosis of ileo-colic, Rt. colic, middle colic, Lt. colic & sigmoidal arteries.
- It gives rise to straight branches called vasa recta, which supply the colon.
- **Surgical Importance:**
  - Vasa recta are end arteries, so, in trauma we do resection & end-to-end anastomosis.
  - Mesenteric vascular occlusion (MVO): occlusion of mesenteric arteries or their branches → adynamic intestinal obstruction.

PORTAL VEIN

Origin: SMV + splenic vein. MCQ

Course

MCQ
- It begins behind neck of pancreas and in front of the IVC.
- It ascends behind 1st part of the duodenum.
- It ascends in the free margin of the hepato-duodenal ligament (lesser omentum) behind CBD to the right & the proper hepatic artery to the left.
- It ends at the porta hepatis.

Length: 3 inches.

Diameter: 0.8 – 1.2 cm

Direct tributaries:

Portal vein drains the whole intra-abdominal alimentary tract + ant. abdominal wall

MCQ
- Lt. and Rt. gastric veins.
- Small pancreatic & duodenal veins.
- Para-umbilical veins into left branch of portal vein.
- Splenic v.
- SMV.
- Cystic vein.

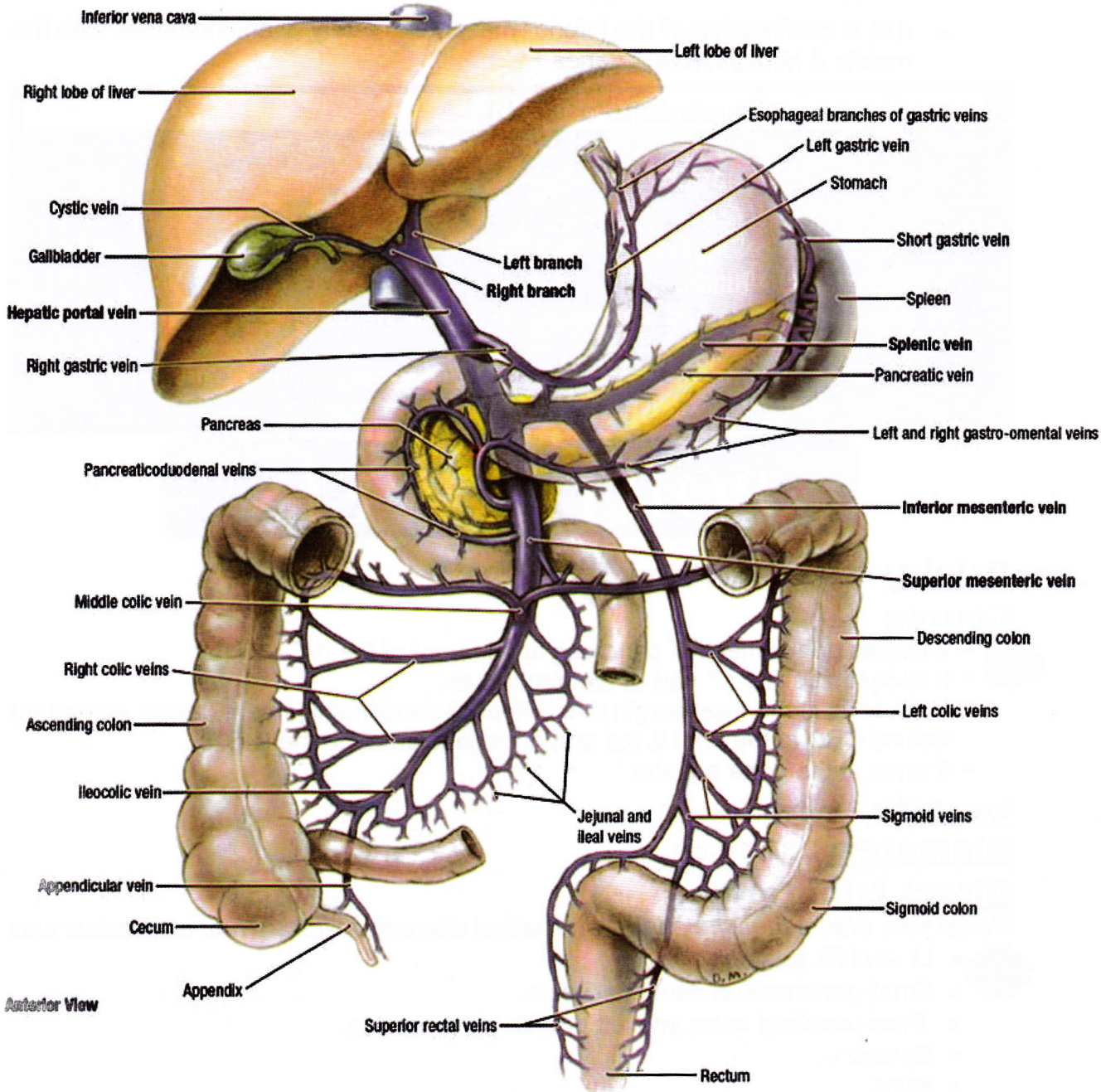
Pressure: 10 - 20 cmH_2O (7 - 11 mmHg).

Surgical Importance:

Collateral Circulation (Porto-systemic Shunts) MCQ

Site	Portal circulation	Systemic circulation
Lower end of esophagus	Left gastric vein	Azygos & hemi-azygos veins
Around the umbilicus	Paraumbilical veins	Anterior abdominal wall veins
Anal canal	Superior rectal vein	Middle & inferior rectal veins
Retroperitoneal space	Mesenteric veins	Lumbar veins
Bare area of the liver	Liver veins	Diaphragmatic veins
Adhesions	Abdominal viscera	Abdominal wall

Normally pressure in systemic veins is lower than portal vein.



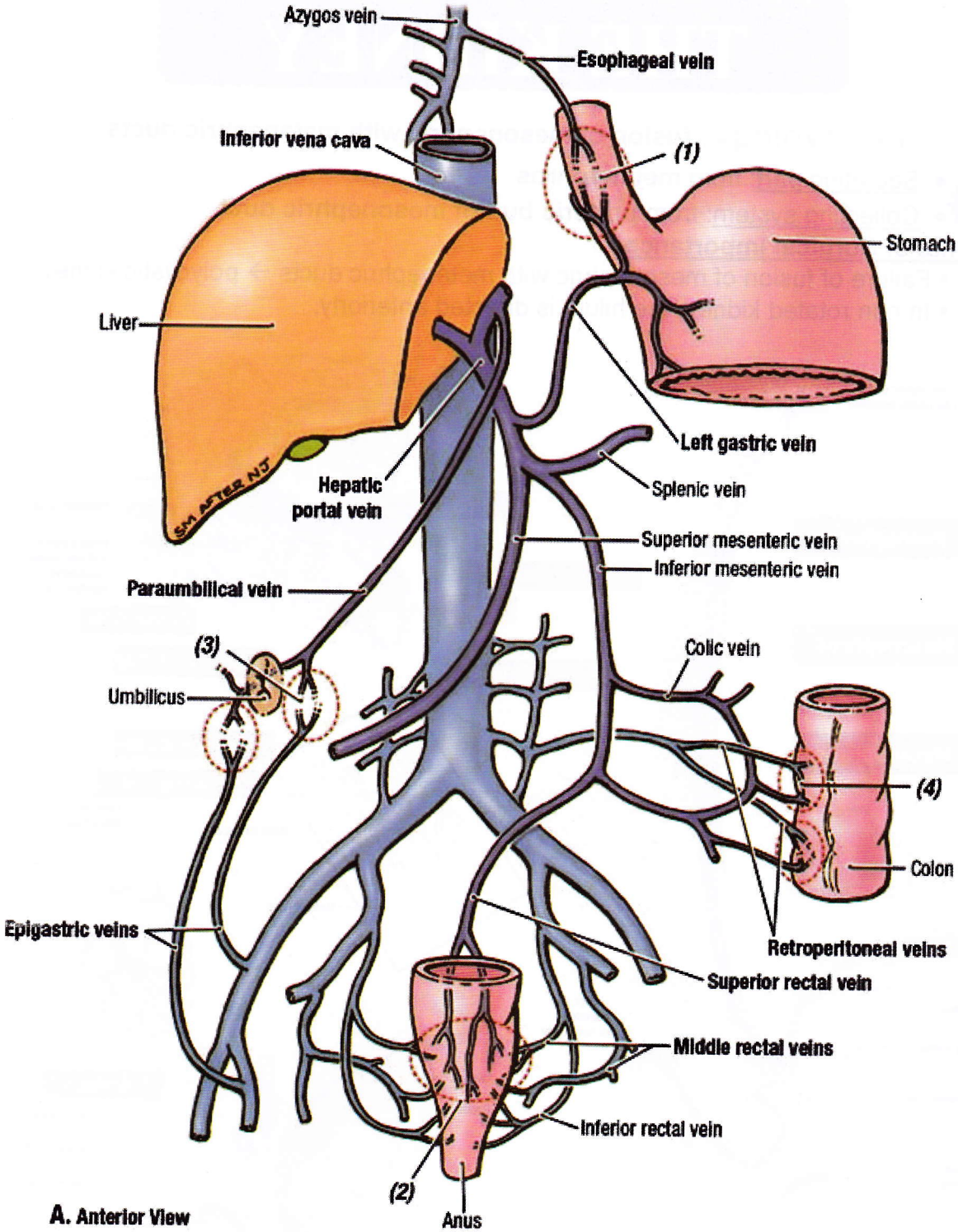
Usually porto-systemic shunts are:

1- Thin walled.

2- Of high pressure.

3- Occur in a patient who has bleeding tendency.

➔ ***Therefore they may cause severe fatal bleeding, so it is better to do surgical shunts***



A. Anterior View

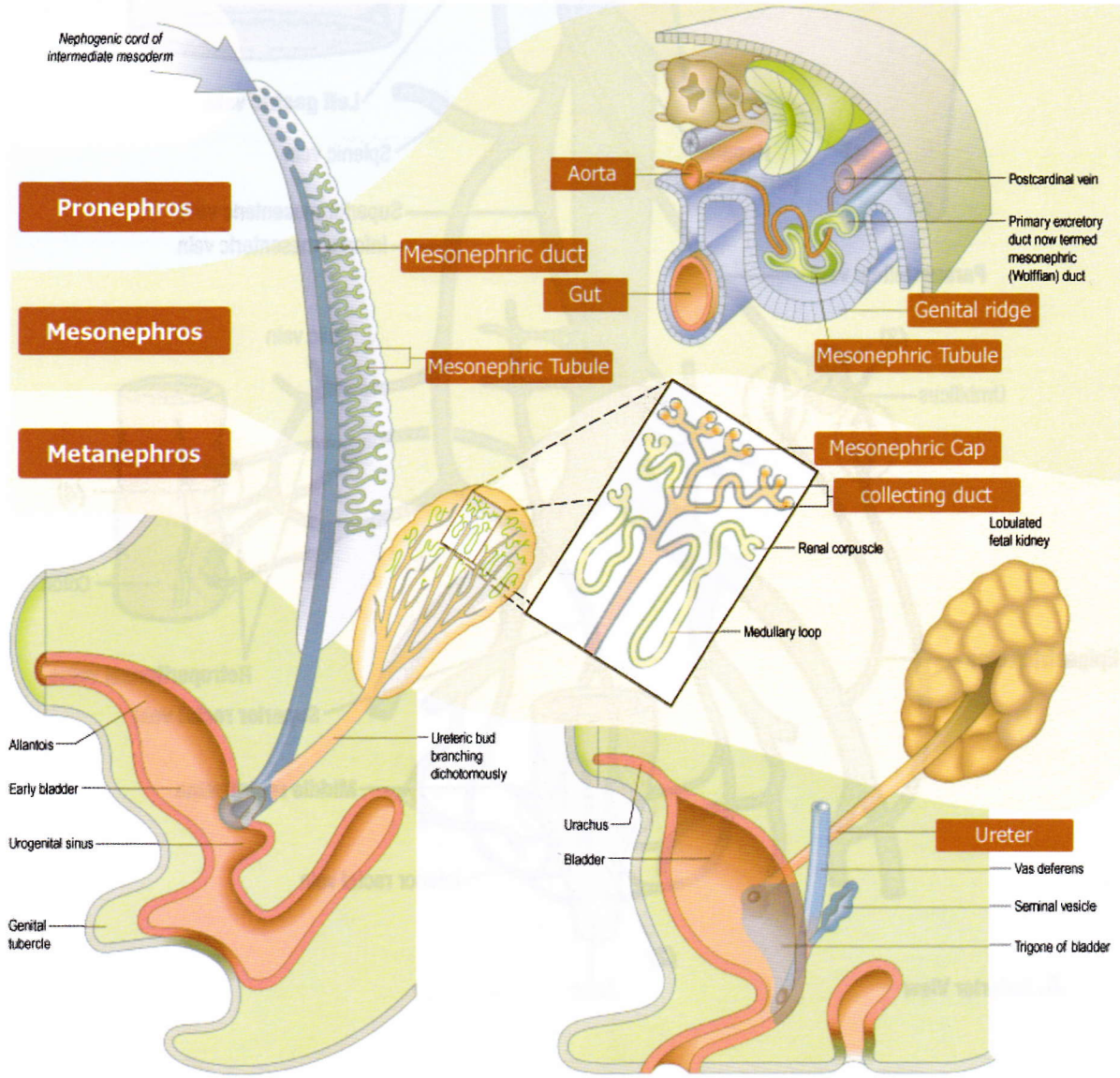
THE KIDNEY

Embryology: **fusion of mesonephric with metanephric ducts.**

MCQ
- Secreting part: from **metanephros**.
- Collecting system: from **ureteric bud of mesonephric duct.**

Points of Surgical Importance:

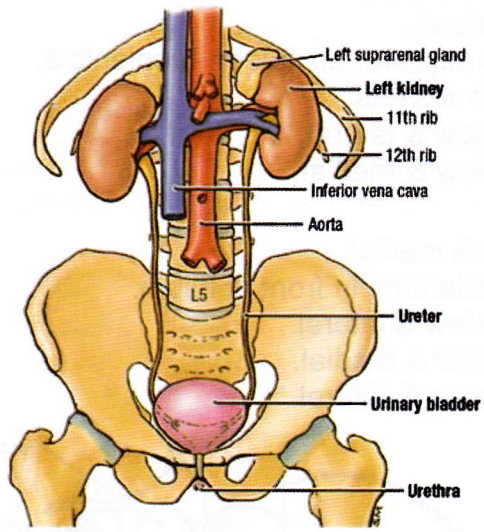
- Failure of fusion of mesonephric with metanephric ducts → polycystic kidney.
- In non rotated kidney, the hilum is directed anteriorly.



Anatomy

Size: 12 X 6 X 3 cm.

Position:



A. Anterior View

- The kidney is retroperitoneal occupying the loins.
- They are in the para-vertebral gutter.
- The Rt. kidney is lower than the Lt. by 0.5 inch because of the pressure of the liver on the Rt. side. (MCQ)

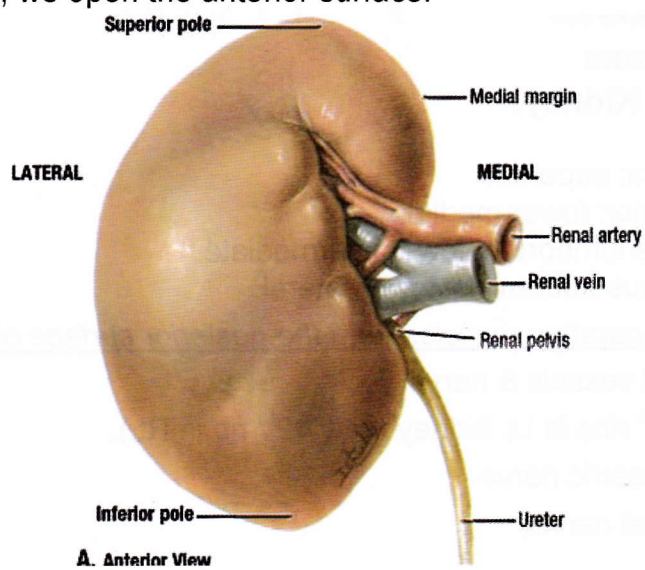
	Rt. Kidney	Lt. kidney
1. Upper pole	Lower border of T_{12}	Upper border of T_{12}
2. Lower pole	lower border of L_3	Upper border of L_3

Pedicle: In the hilum we have (VAP) (MCQ)

- Renal vein → anterior
- Renal artery → middle
- Pelvis of the ureter → posterior

Surgical Importance:

- In nephrolithotomy, we open the posterior surface while at radical nephrectomy, we open the anterior surface.



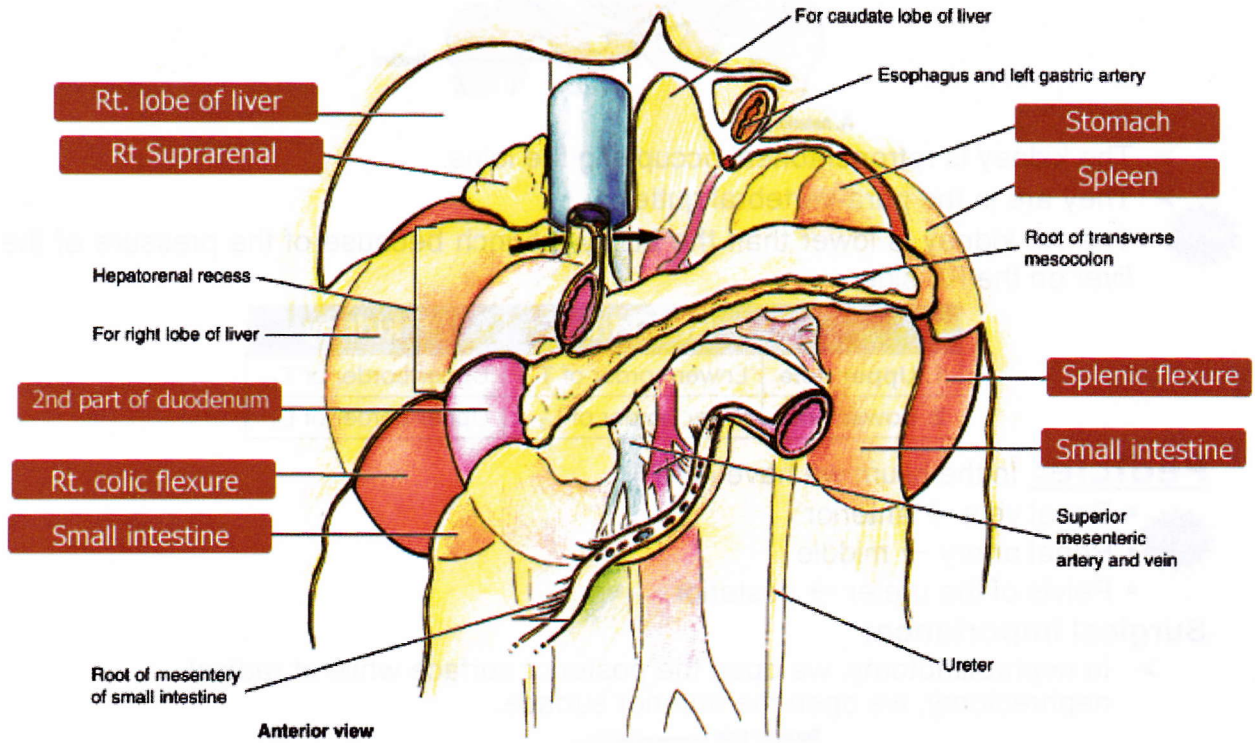
A. Anterior View

Relations MCQ

Anterior Relations

- Left Kidney (stomach bed)
  - Suprarenal: above & medial.
  - Spleen: above & lateral.
  - Stomach: between suprarenal, spleen & splenic a.
  - Pancreas & splenic vessels.
  - Splenic flexure: below & lateral.
  - Small intestine: below & medial.
- Right Kidney
  - Suprarenal: above & medial.
  - Second part of duodenum: in front of hilum.
  - Rt. colic flexure: below & lateral.
  - Small intestine: below & medial.
  - Rt. lobe of liver: above & lateral.

} No peritoneum in between



Posterior Relations

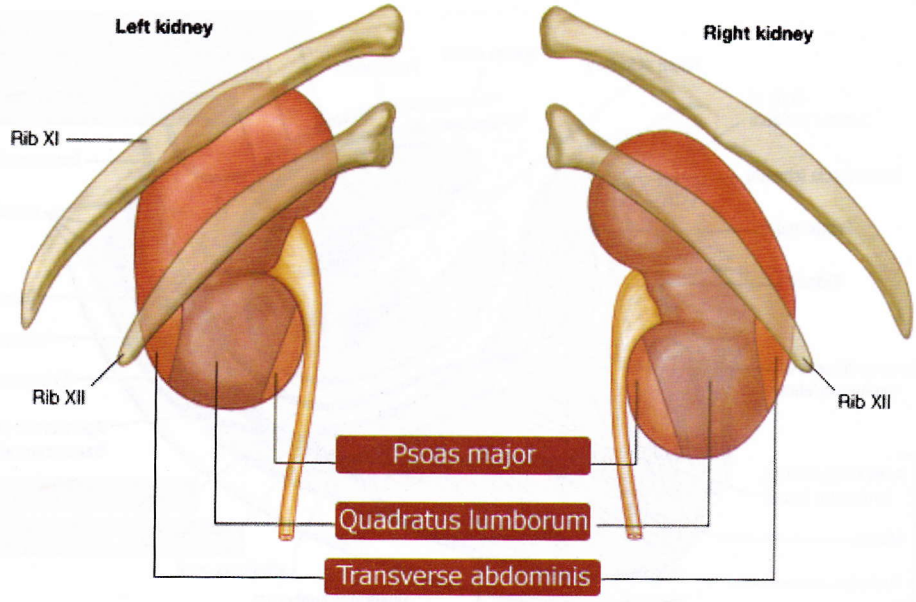
- **Both Rt. & Lt. Kidney.**

4 Muscles

1) Diaphragm: superior.
2) Psoas major: lower medial.
3) Quadratus lumborum: lower intermediate.
4) Transversus abdominis: lower lateral.

4 structures separating muscles from the posterior surface of kidney

1) Subcostal vessels & nerve.
2) 11th & 12th ribs in Lt. kidney (only 12th rib in Rt.).
3) Ilio-hypogastric nerve.
4) Ilio-inguinal nerve.

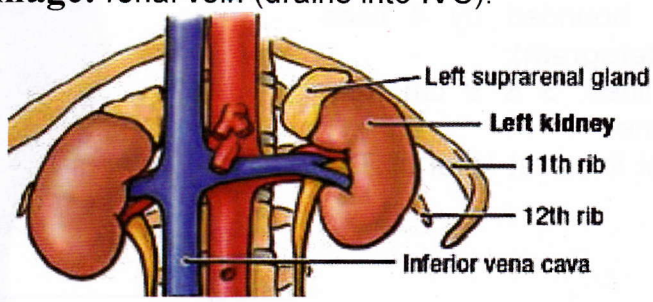


Blood Supply of the Kidney:

MCQ 1) **Arterial supply:** renal artery (branch of abdominal aorta at L1/L2).

- Rt. renal artery is longer than Lt renal a. & it passes behind IVC.
- Blood supply to the kidney is segmental → end arteries.
- Accessory renal arteries:
  - Are of common occurrence.
  - Usually arise from the abdominal aorta.
  - Can cause ureteric obstruction.
  - Ligation → infarction of the part supplied by them.

2) **Venous drainage:** renal vein (drains into IVC).



Capsule of the Kidney:

A- Fascia Of Züker-candle (Gerota) (Peri-renal capsule)

The fascia transversalis reaching the kidney splits into:

- Anterior layer → attached to aorta.
- Posterior layers → attached to vertebral fascia.

The two layers:

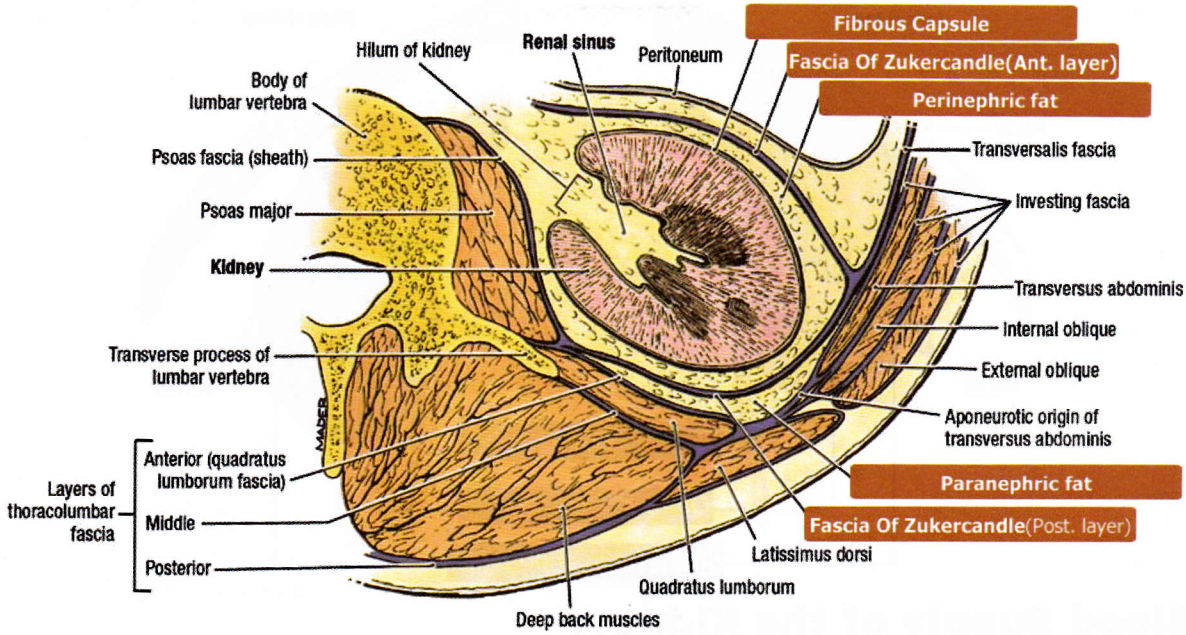
- Above → fuse above.
- Below → no fusion.

MCQ N.B: Gerota fascia encloses the kidney BUT NOT the adrenal gland.

B- Fibrous Capsule.

C- Peri-nephric fat.

- **Surgical Importance** no fusion from below → kidney is liable to ptosis.



B. Transverse Section

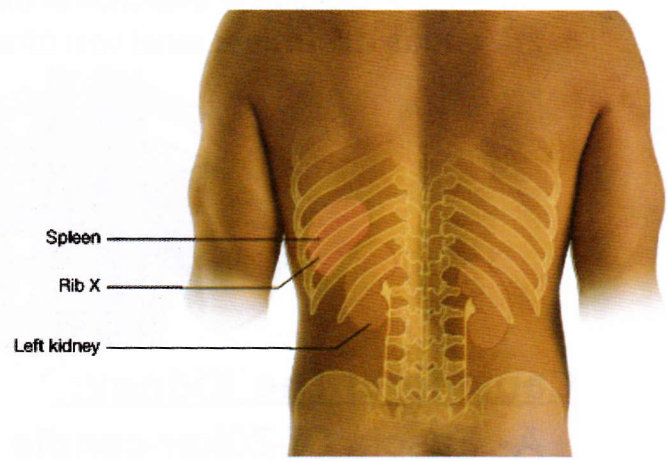
Stability of the kidney:

a- Its position in the para-vertebral gutter.
b- Its fascial & fatty capsules.
c- The renal vessels connecting the kidney to Aorta & IVC.
d- The intra-abdominal pressure.

Surface Anatomy of the Kidney:

A. Posterior surface marking of the kidney: bounded by 4 lines **(Morris' parallelogram)**:

- 2 vertical lines: 3 & 9 cm from median plane.
- 2 horizontal lines: at level of T11 and L3.



B. Anterior surface marking of the kidney:

	Right kidney	Left kidney
Upper end	11^{th} space	11^{th} rib
Lower end	5 cm above iliac crest	6.5 cm above iliac crest

SURGICAL NOTES

- Lt. kidney is higher than Rt. → rib resection may be needed in Lt. kidney operations.
- Rt. Nephrectomy is mre dangerous than the Lt. due to its relation to the biliary duct, 2^{nd} part of the duodenum & ampulla of vater, aslo short Rt. Renal v.

SUPRARENAL GLAND

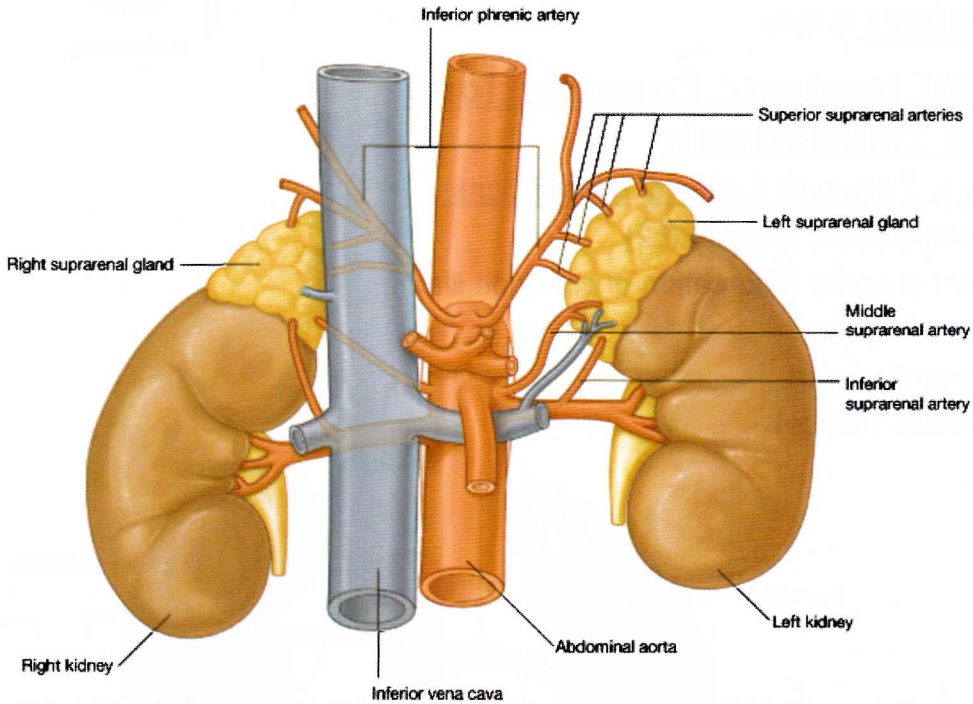
Site: **On the upper pole of the kidney.**

Shape:

MCQ

- The Rt. suprarenal gland is pyramidal.
- The Lt. suprarenal gland is semi-lunar.

RELATIONS



	Rt. Supra renal gland	Lt. supra renal gland
Anterior	Rt. lobe of the liver.	Lesser sac of the stomach.
Posterior	Rt. crus of the diaphragm	Lt. crus of the diaphragm

Blood supply:

MCQ

Arterial Supply:

- 3 arteries for each gland.
- Arteries do not enter through the hilum:
  1) Superior suprarenal artery from the inferior phrenic artery.
  2) Middle suprarenal artery from the abdominal aorta **(main supply)**.
  3) Inferior suprarenal artery from the renal artery.

Venous Drainage: single vein leaves through the hilum.

1) Rt. suprarenal v. → IVC
2) Lt. suprarenal v. → Lt renal v.

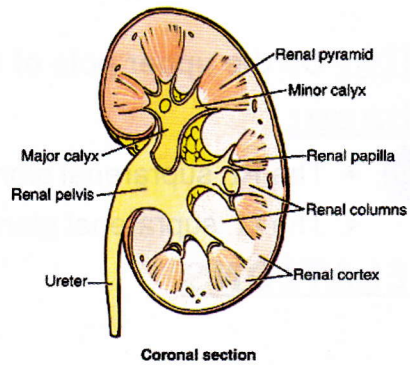
- The short length of the Rt. supra renal v. makes its ligation difficult at surgery.
- The Rt. gland is tucked up under the inferior vena cava.

THE URETER

Formed by union of 3 major calyces to form the pelvis of ureter, which is either:

1. Internal: Causing renal type of hydronephrosis
2. External: Causing pelvic type of hydronephrosis

➢ Minor calyces are 10 - 12 having a waist.



Coronal section

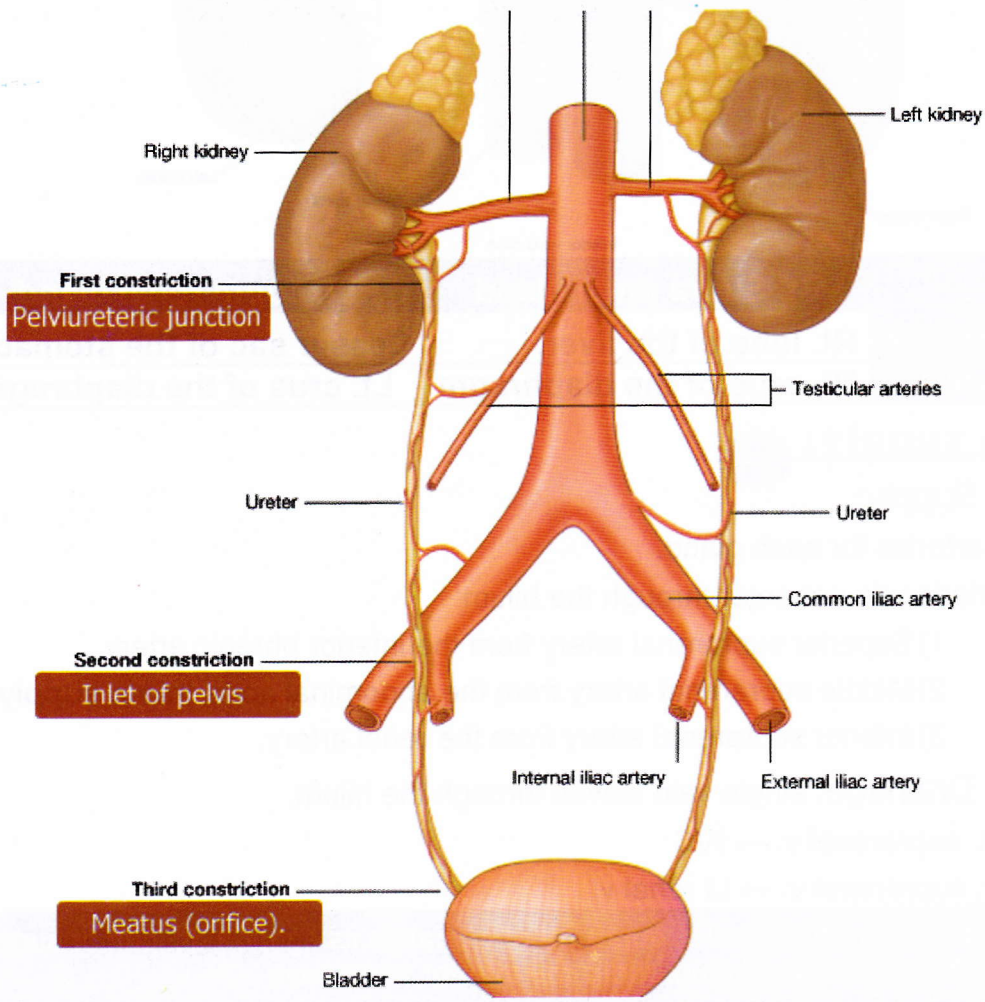
Length: 25 – 30 cm

Dtameter: 6 mm

Sites Of Ureteric Constrictions (Stone Impaction):

Diameter is 3 mm with 5 sites of constrictions:

1) Pelvi-ureteric junction (L2).
2) Inlet of pelvis (bifurcation of common iliac).
3) Ischial spine.
4) Intramural part.
5) Meatus (orifice).



Parts of the Ureter:

1) Abdominal part: 12.5 cm

	Right Ureter	Left Ureter
Course	Each ureter descends vertically behind the peritoneum of the posterior abdominal wall opposite the tips of transverse processes of lower 4 lumbar vertebrae (the same course in both ♂ & ♀).	
Post. relation	• Medial border of psoas major & genito-femoral nerve on it. • Tips of transverse processes of the lower 4 lumbar vertebrae	
Ant. relation	• 3rd part of the duodenum	
	• 3 arteries: Rt. gonadal, Rt. colic & ileo-colic.	• 3 arteries: Lt. gonadal, upper & lower Lt. colic.
	3 structures related to mesentry: • its root • sup. mesentric vessels • coils of ileum	• It passes behind the fossa intersigmoidae • Sigmoid mesocolon • Coils of sigmoid colon
Medial relation	IVC	Inferior mesenteric v.

2) Pelvic part: 12.5 cm MCQ

- It enters the pelvis by crossing in front of the bifurcation of common iliac artery (at the sacroiliac joint).
- It runs downwards & backwards on the side of pelvic wall till it reaches ischial spine with the following relations:
  - Anterior: peritoneum (it is retro-peritoneal).
  - Posterior: internal iliac vessels.
  - Lateral: obturator nerve & vessels & the umbilical artery.
- At the level of ischial spine, it curves antero-medially crossing over the levator ani muscle to open into the postero-superior angle of urinary bladder.

Here, its course is different in ♂ & ♀:

- In ♂: crossed by the vas deferens from lateral to medial.
- In ♀: it crosses posterior to the uterine artery 2 cm lateral to the cervix.

3) Intramural part:

It is 2 cm long, runs on oblique course in the bladder wall.

Blood Supply: (Segmental)

- UPPER ⅓ → renal artery.
- MIDDLE ⅓ → gonadal, aorta & common iliac.
- LOWER ⅓ → vesical in male & uterine in female.

Identification Of Ureter In X-Ray

It runs in front of:

1. Tips of the transverse processes of lumbar vertebrae.
2. Ilio-sacral joint.
3. Ischial spine.

Identification during operation

Anatomical site:

- Lies on psoas major & seen crossing:
- The bifurcation of common iliac.
- The ischial spine.

It is not an artery: since the pulsations are not continuous but peristalsis.

It is not Psoas minor:

- Psoas Minor: Flat shining tendon.
- Ureter: white cord-like (tubular).

It is not a colon:

- Colon: Blood vessels run circular.
- Ureter: Blood vessels run longitudinally.

The stone is the best guide for the Ureter

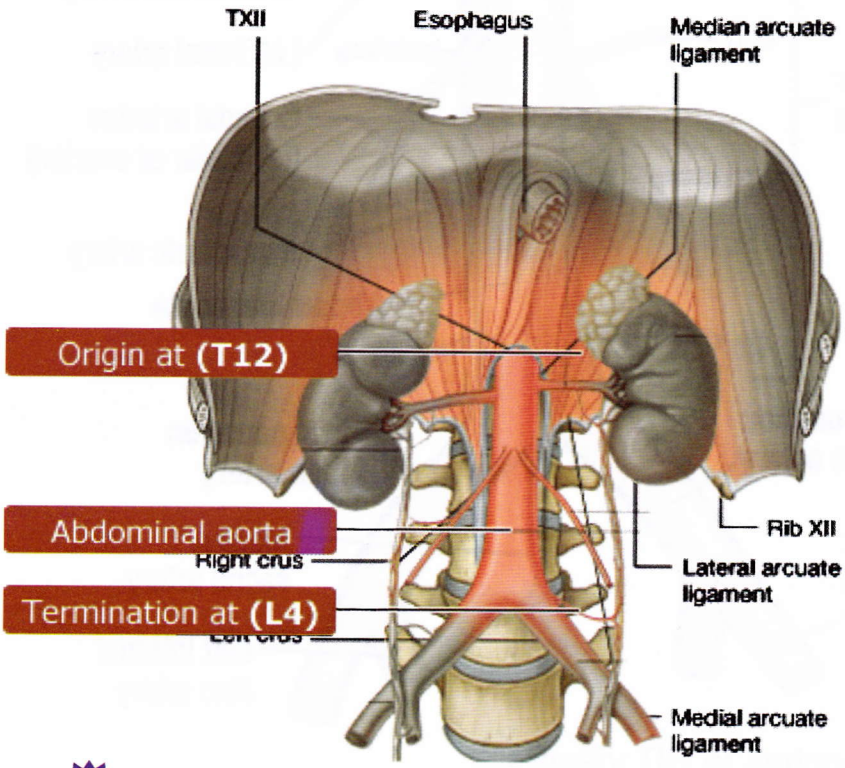
MCQ

During operation:

- Abdominal ureter should be mobilized medially.
- Pelvic ureter should be mobilized laterally (receives its blood supply from lateral side).
- The ureter remains attached to the undersurface of the peritoneum when the latter is reflected at surgery.

BLOOD VESSELES OF THE ABDOMEN

Abdominal Aorta



Origin: MCQ

- At the aortic opening in the diaphragm opposite the **lower border of T12** in the median plane behind the median arcuate ligament & between the Rt. & Lt. crura.
- It is a continuation of the thoracic aorta.
- *Aortic pulsation can be felt just to the left of the umbilicus.*

Termination

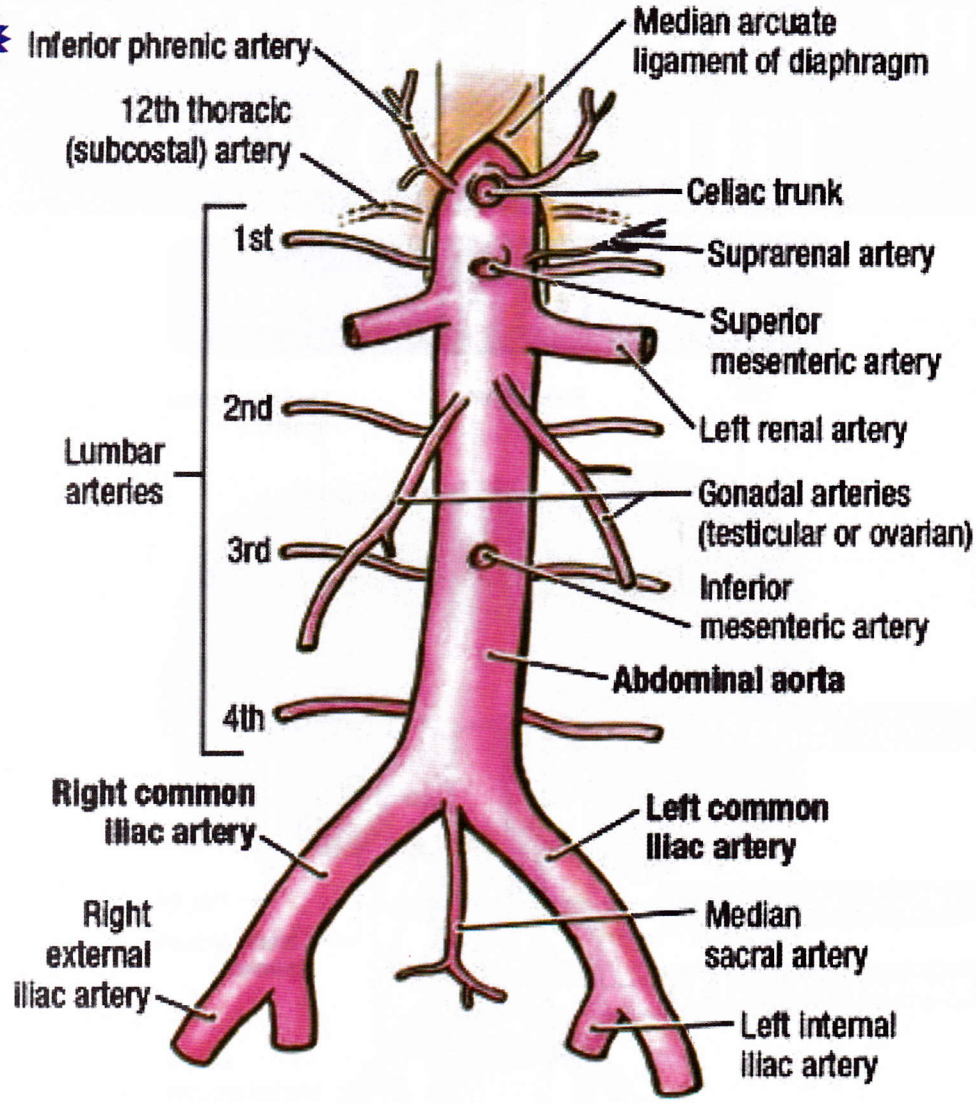
- At **L4 vertebra** slightly to the left by dividing into 2 terminal branches (2 common iliac arteries).

Relations: MCQ

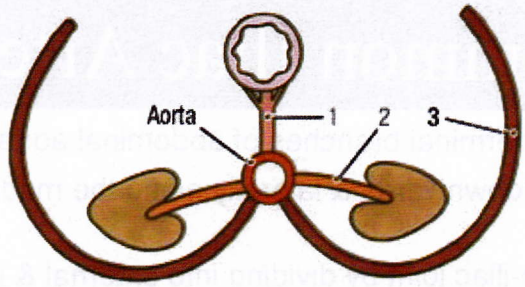
- **Posterior:** it lies directly anterior to L1 - L4.
- **Structures cross anterior to aorta include:**
  - Left renal vein.
  - Root of mesentery.
  - 3rd part of duodenum.
- **On its left side:** Is closely related to the Lt sympathetic trunk.
- **On its right side:** IVC, cisterna chyli.

Branches

MCQ



- **3 single branches to GIT viscera**
  - Celiac trunk → Starts at upper border of L1.
  - Superior mesenteric a.→ Starts at lower border of L1.
  - Inferior mesenteric a.→ Starts at L3.
- **3 paired branches to the gland**
  - Middle suprarenal a.
  - Renal artery a. (L2).
  - Gonadal (testis or ovarian) lower border of L2.
- **3 terminal branches**
  - Rt. common iliac a.
  - Lt. common iliac a.
  - Median sacral a.
- **5 paired branches to the walls**
  - Phrenic a. (to the diaphragm): one pair.
  - Lumbar arteries (to abdominal wall & spinal cord): 4 pairs.



Three Vascular Planes

	Vascular plane	Class	Distribution	Abdominal Branches (Arteries)	Vertebral Level
1	Anterior midline	Unpaired visceral	Alimentary tract	Celiac	T12
				Superior mesenteric (SMA)	L1
				Inferior mesenteric (IMA)	L3
2	Lateral	Paired visceral	Urogenital and endocrine organs	Suprarenal	L1
				Renal	L1
				Gonadal (testicular or ovarian)	L2
3	Postero-lateral	Paired parietal (segmental)	Diaphragm Body Wall	Subcostal	T12
				Inferior phrenic	T12
				Lumbar	L1–L4

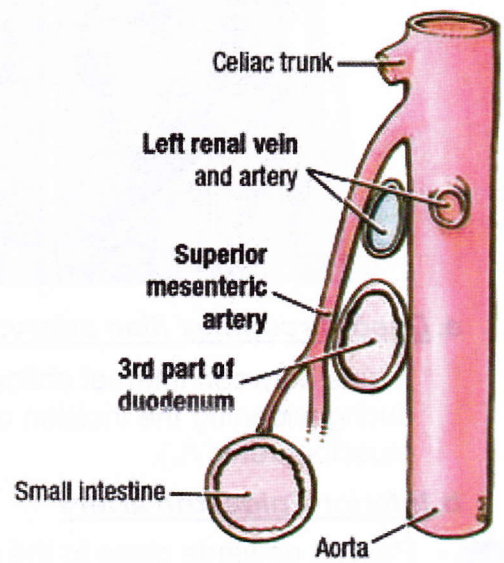
N.B: *If lumbar arteries are obstructed → paraplegia due to spinal cord infarction.*

Exposure:

- **Incision:** The abdominal aorta is exposed by a long midline incision extending from the xiphoid process to the pubis.
- **Indication**: The most common indication is for aneurysm which lies **below the level of the renal arteries in 95% of cases.**
- **Procedure**:
  1) The peritoneum in Lt. para-colic gutter is incised laterally to the Lt. colon & extended above to the diaphragm & below to the pelvic brim.
  2) Left colon, left kidney, spleen, body & tail of pancreas & fundus of the stomach are retracted upwards and to the right in the relatively avascular retroperitoneal plane.

Surface anatomy:

- Draw the following points:
  - 2.5 cm above the transpyloric plane in anterior median line.
  - 1 cm below & to the Lt. of the umbilicus.
  - Draw 2 parallel lines 2 cm apart by joining the previous points.



Lateral View (from left)

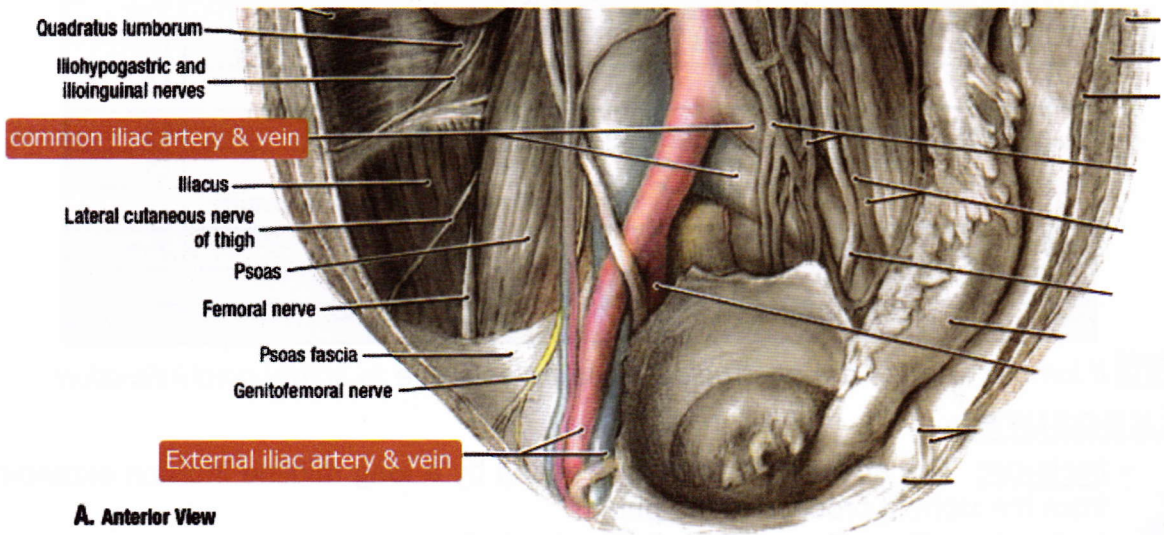
Common Iliac Artery

Origin: one of the 2 terminal branches of abdominal aorta at lower border of L4.

Course: it descends downwards & laterally along the medial side of psoas major muscle.

End: opposite to sacro-iliac joint by dividing into external & internal iliac arteries.

External Iliac Artery

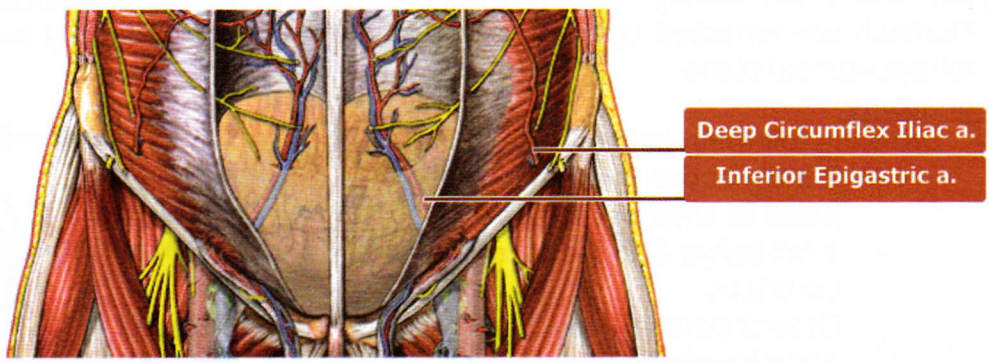


A. Anterior View

Origin: at the sacroiliac joint as the larger of the two terminal branches of the common iliac artery.

Ends: at mid inguinal point where it continues as the femoral artery in the thigh.

Branches:



a. Deep Circumflex Iliac artery:

It runs between internal oblique & transversus abdominis, so it can be injured during widening the incision of appendectomy (it anastomoses with musclophrenic A.).

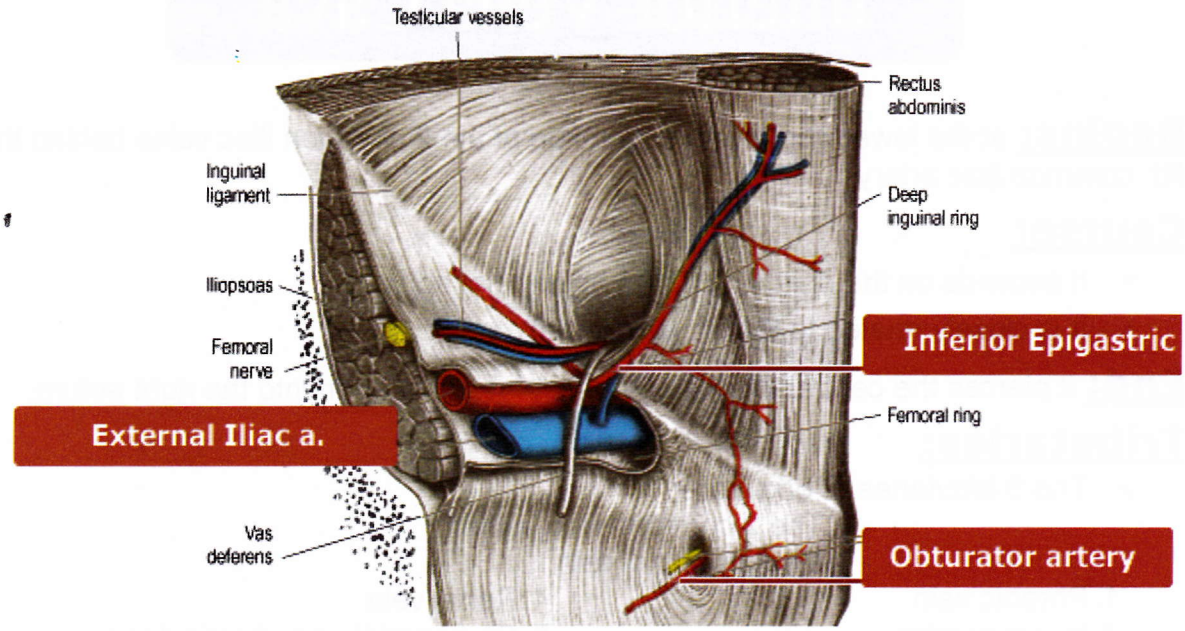
b. Inferior Epigastric artery

MCQ

- Passes upwards close to the medial margin of deep inguinal ring.
- Then it pierces fascia transversalis (posterior wall of rectus sheath) to enter the sheath where it anastomoses with superior epigastric artery.

- **Branches:-**
  - Pubic branch: anastomose with pubic branch of obturator A.
  - Cremaseric branch: anastomose with testicular A.
- It ascends close to the medial margin of the deep ring, then enter the posterior wall of rectus sheath to anastomose with superior epigastric A. at the level of the umbilicus.

Surgical Importance of inferior epigastric artery:



1. It forms the lateral border of Hasselbach's triangle.
2. Lies between direct & indirect inguinal hernias (direct medially & indirect laterally).
3. Lies between the two limbs of pantaloon hernia.
4. It marks the neck of hernial sac during herniotomy.
5. In Orchiopexy, if additional length is needed, this artery is cut and anastomosed with testicular artery giving more length for the spermatic cord.
6. In sometimes give an abnormal obturator artery (large pubic branch):

MCQ
- *Present in 30% of population.*
- *20% in safe site.*
- *10% in dangerous site.*

N.B: ***Enlarging the femoral ring medially to relieve strangulation of femoral hernia sometimes → severe hemorrhage due to tear of abnormal obturator a.***

7. It gives the cremasteric artery.
8. There is an anastomosis between subclavian & external iliac arteries, in which the inf. epigastric a. participates (important in **LERICH** syndrome)

Exposure of iliac vessels

- These vessels can be approached extra-peritoneally by an oblique incision such as the one used for the ureter.
- The incision runs obliquely forwards from the loin in the direction of the symphysis pubis up to the lateral border of the rectus abdominis.
- This incision exposes the whole length of iliac vessels, including the aortic bifurcation, but the exposure afforded to the opposite iliac vessels is poor.

Surface anatomy of common iliac & external iliac arteries

- Draw the following points:
  - 1 cm below & to the Lt. of the umbilicus.
  - Midinguinal point.
- Join the 2 points by a broad line, the upper 1/3 of this line represent the common iliac A. while the lower 2/3 represent the external iliac A.

Inferior Vena Cava

Begins: at the lower border of L5 by union of the 2 common iliac veins behind the Rt. common iliac artery.

Course:

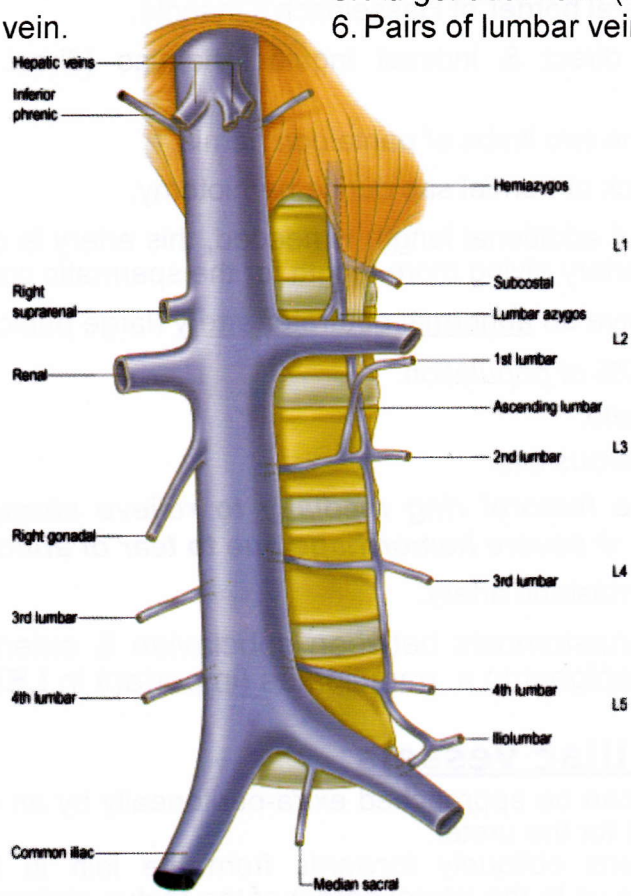
- It ascends on the right side of the abdominal aorta.
- It is closely related to the Rt. sympathetic trunk.

End: it pierces the central tendon of the diaphragm to open into the right atrium.

Tributaries:

- The 3 tributaries of origin are:
  - The 2 common iliac veins.
  - Median sacral vein

1. Phrenic vein.
2. Hepatic veins.
3. Rt. suprarenal vein.
4. Renal vein.
5. Rt. gonadal vein. (testicular or ovarian)
6. Pairs of lumbar veins.



DIAPHRAGM

Development of the Diaphragm:

The diaphragm, pericardium & heart are formed in the neck, and thus obtain their nerve supply from there. They migrate to their final sites carrying their nerve supply with them.

Septum transversum:

It separates pericardial development (ventrally) from developing gut (dorsally). It moves to lie caudal to pericardial cavity. It descends from neck to form the central tendon of the diaphragm.

Body wall (transverse layer) and pleura-peritoneal membranes:

Both grow inwards to fuse with septum transversum and give the diaphragm.

Dorsal mesentry of the esophagus:

Completes the diaphragm posteriorly.

Note:

- Despite this complex development, few defects occur in the diaphragm. Perhaps the severer ones are incompatible with life.
- The important sites of hernia:

Origin: MCQ

a- ***Sternal***: back of xiphoid process.

b- ***Costal***: lower 6 costal cartilages.

c- ***Vertebral:***

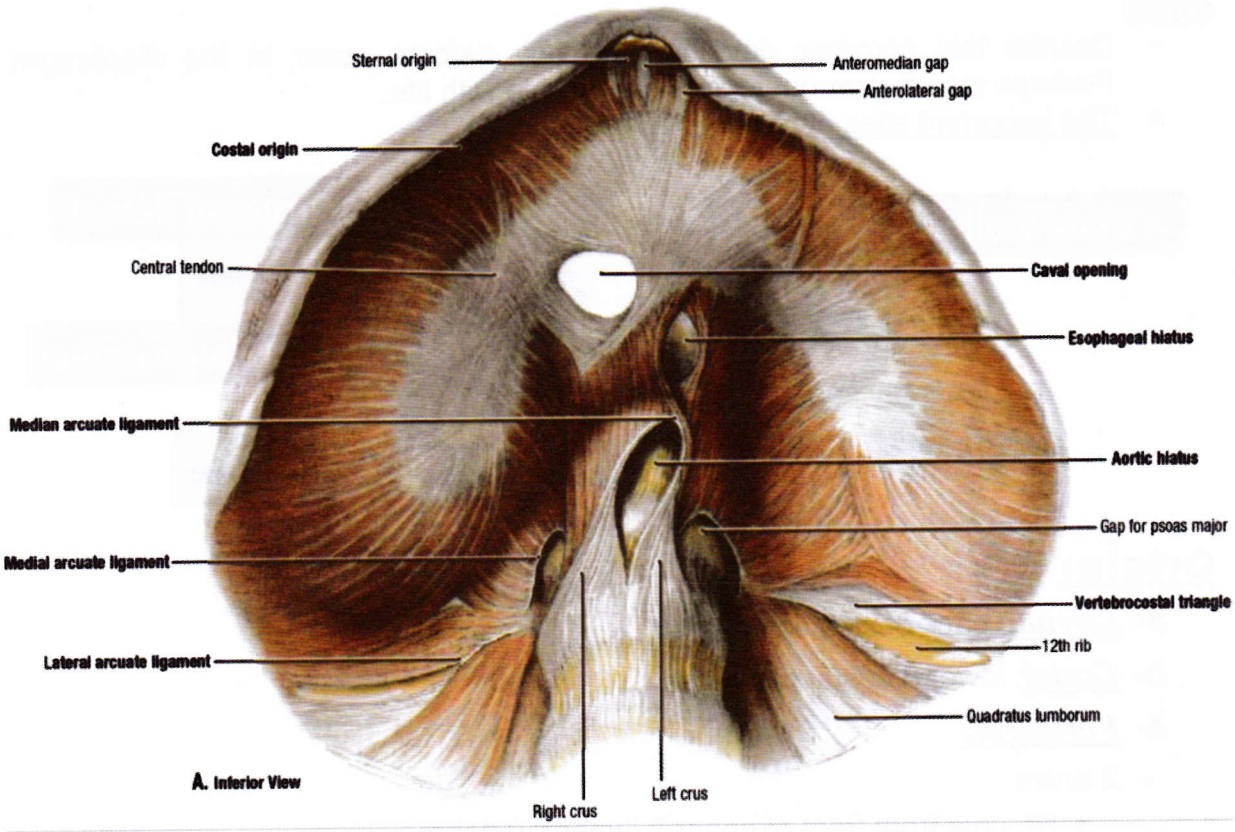
- ***2 crura***
  - Rt. crus from front of upper 3 lumbar vertebrae.
  - Lt. crus from front of upper 2 lumbar vertebrae.
- ***5 arcuate ligaments***
  - 2 lateral → bridges over quadrates lumborum muscle
  - 2 medial → bridges over psoas major muscle
  - 1 median

Insertion: central tendon MCQ

Openings in the diaphragm:

MCQ The three large openings in the diaphragm are shown in table

Opening	Level	Structures traversing
Caval opening	**T 8,** 1 inch to the Rt. inside central tendon	- IVC - Rt. phrenic n - Lymph vessels
Esophageal opening	**T 10**, 1 inch to the Lt. inside Rt. crus	- Esophagus - 2 vagi nerves - Esophageal vessels
Aortic opening	**T 12**, Midline behind median arcuate ligament	**From Lt. to Rt.** - Abd. Aorta - Azygos vein - Thoracic duct



Nerve Supply of the Diaphragm MCQ

1-**Phrenic nerve** (C4) is the motor nerve to the diaphragm and is also sensory to the central region. This explains referred pain from diaphragm to the shoulder.

2-The peripheral region of the diaphragm which develops from the body wall receives sensory nerves from the **lower six or seven intercostal nerves**.

Phrenic nerves:

- They are branches of the cervical plexus (C3,**4**,5).
- They lie at the base of the neck being:
  - anterior to the scalenus anterior muscles.
  - beneath the pre-vertebral fascia.
- They enter the chest by passing superficial to subclavian artery & run anterior to the root of lung.

The distribution of the phrenic nerve on the diaphragm is best seen on the inferior surface.

NB: The intercostal nerve & vessels in the costal groove are arranged from above downward as: **Vein, Artery & Nerve** → related to the inferior surface of the rib.

Action: MCQ

- It is the chief (involuntary) muscle of inspiration (contraction → central tendon descends & intra-thoracic pressure decreases).
- It can also be used voluntarily to increase pressure in the abdomen.
- Contraction of diaphragm assists in venous return to the heart.
- Contraction of Rt. crus helps in preventing regurgitation of food from stomach into the esophagus (pinch-cock mechanism).

Relations:

- **Relations of the Upper Surface:**
  - Pleura & lung on both sides.
  - Base of pericardium in the middle.
- **Relations of the Lower Surface:**
  - Liver, kidney & suprarenal gland (on both sides).
  - Spleen & stomach (on the left).

Points of Surgical Importance:

Foramen of Morgagni or Magendi:

- Between the sternal & costal origins of the diaphragm through which para-sternal (anterior) diaphragmatic hernia may develop.

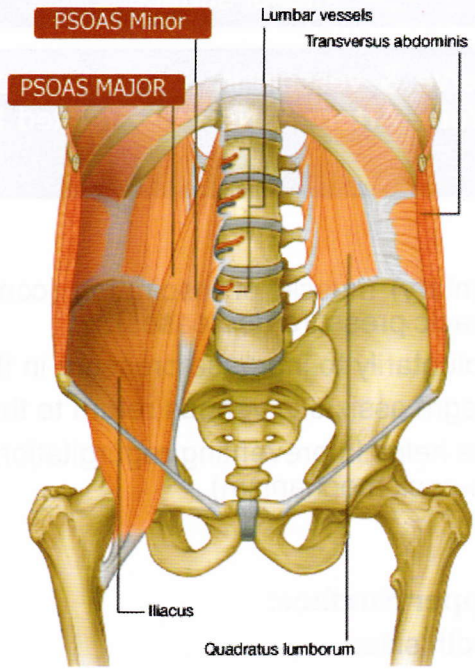
Foramen of Bochdalek:

- *Due to:* persistent pleura-peritoneal canal.
- *Site*: It is a triangular gap between the lat rib & the diaphragm.
- Posterior diaphragmatic hernia may develop through it.

PSOAS MAJOR

Origin: MCQ

1) Front of the transverse processes of all lumbar vertebrae.
2) By 5 digitations, each of which arises from the sides of the bodies of each 2 adjacent lumbar vertebrae and the inter-vertebral discs in between.
3) From tendinous arches attached to the sides of the lumbar vertebrae. These arches bridge over the lumbar arteries.



Insertion: MCQ

- The muscle descends medial to iliacus muscle & continues downwards to enter the front of the thigh **behind inguinal ligament above superior pubic ramus.**
- Its tendon receives fibers of the iliacus muscle and is inserted into the **lesser trochanter of femur**.

Nerve Supply: branches from the lumbar plexus (L 1, 2, 3).

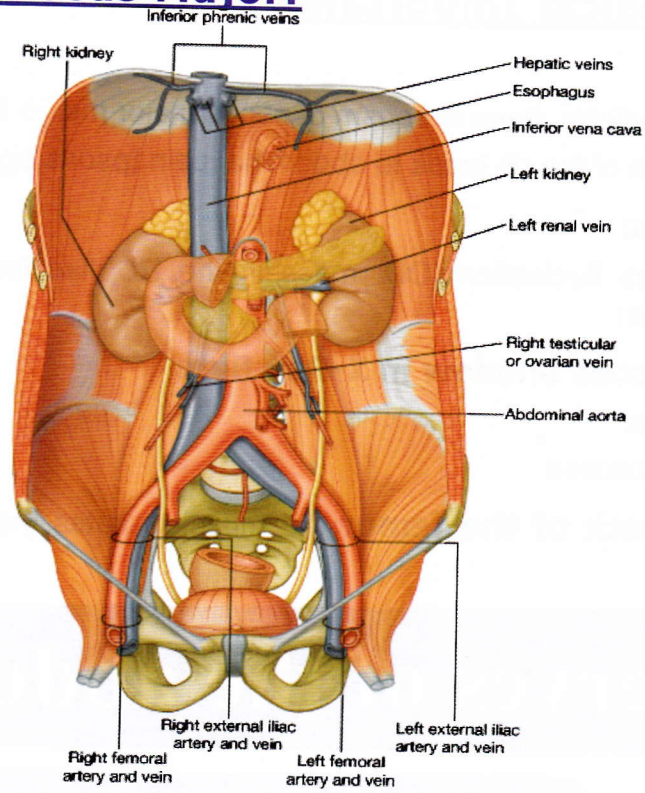
Action:

MCQ
1) It flexes the thigh and rotates it medially. But in fracture of the neck of femur, the muscle rotates the thigh laterally.
2) Acting from below, the muscle bends the trunk forwards.

Psoas fascia

The Psoas Major is enveloped by the psoas fascia, which is thickened in its upper part to form the ***medial arcuate ligament***.

Relations of Psoas Major:



Anteriorly:

Common for Lt. and Rt. muscles

1) Kidney and its renal vessels.
2) Ureter and renal pelvis.
3) Gonadal vessels.
4) Genito-femoral nerve.
5) Psoas minor (in 60% of population).
6) End of the ileum (on the right) and descending colon (on the left).
7) Inguinal ligament.

Specific for Lt. muscle:

4th part of duodenum, root of mesentery and superior mesenteric vessels.

Specific for Rt. muscle:

IVC, 2nd and 3rd parts of duodenum.

Posteriorly:

1. Transverse processes of lumbar vertebrae.
2. Superior pubic rami.

Laterally:

1. Quadratus lumborum (above).
2. Iliacus (below).
3. Ilio-hypogastric nerve.
4. Ilio-inguinal nerve.
5. Lateral cutaneous nerve of thigh.
6. Femoral nerve (the lower most).

Medially:

1) Sympathetic trunk (along its medial margin).
2) External iliac vessels (at the brim of the pelvis).
3) 2 nerves: obturator nerve and lumbosacral trunk.

Points of Surgical Importance:

a. Psoas sign:

- In acute appendicitis, there is spasm of psoas major ms. → flexion deformity.
- Hyperextension of the rib leads to abdominal pain (psoas sign).

b. Psoas Abscess:

- Produces cross fluctuation (DD: mass in the Rt. iliac fossa & mass in the femoral triangle).

c. Obliterated Psoas Shadow in X-Ray film:

- Rupture spleen.
- Peri-nephric abscess.

d. In fracture neck of the femur the muscle rotates the thigh laterally (not medially).

Nerves of the abdomen

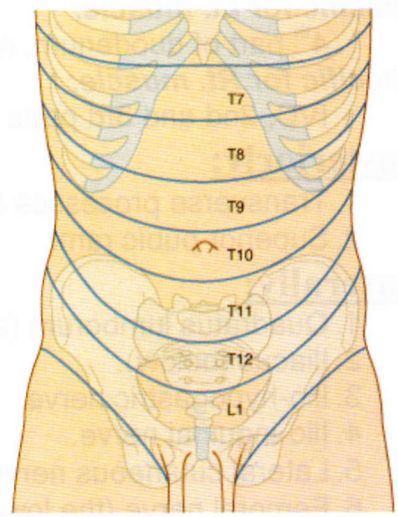
Lumbar Plexus

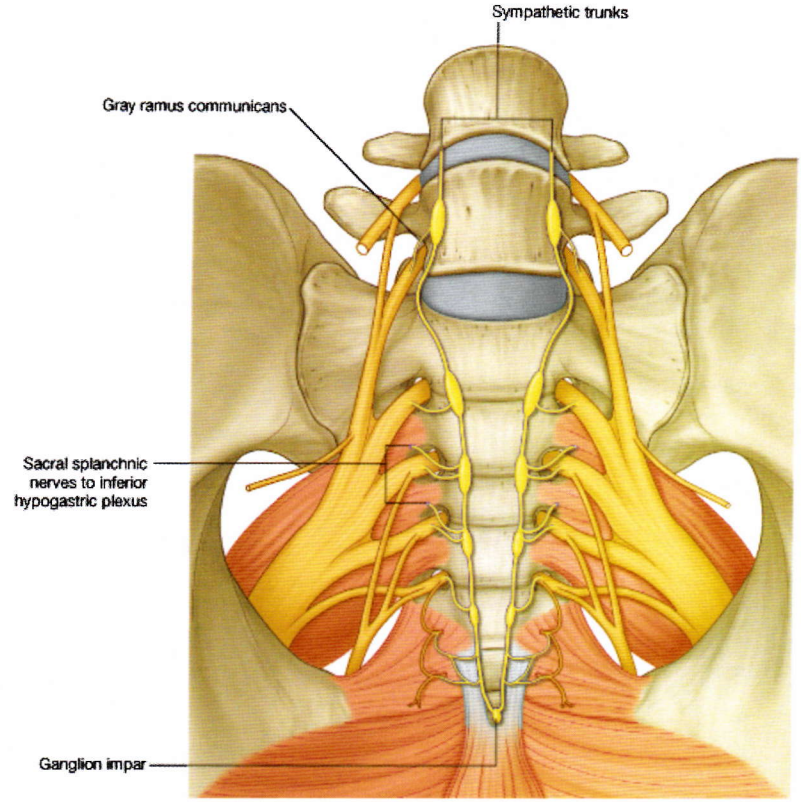
MCQ

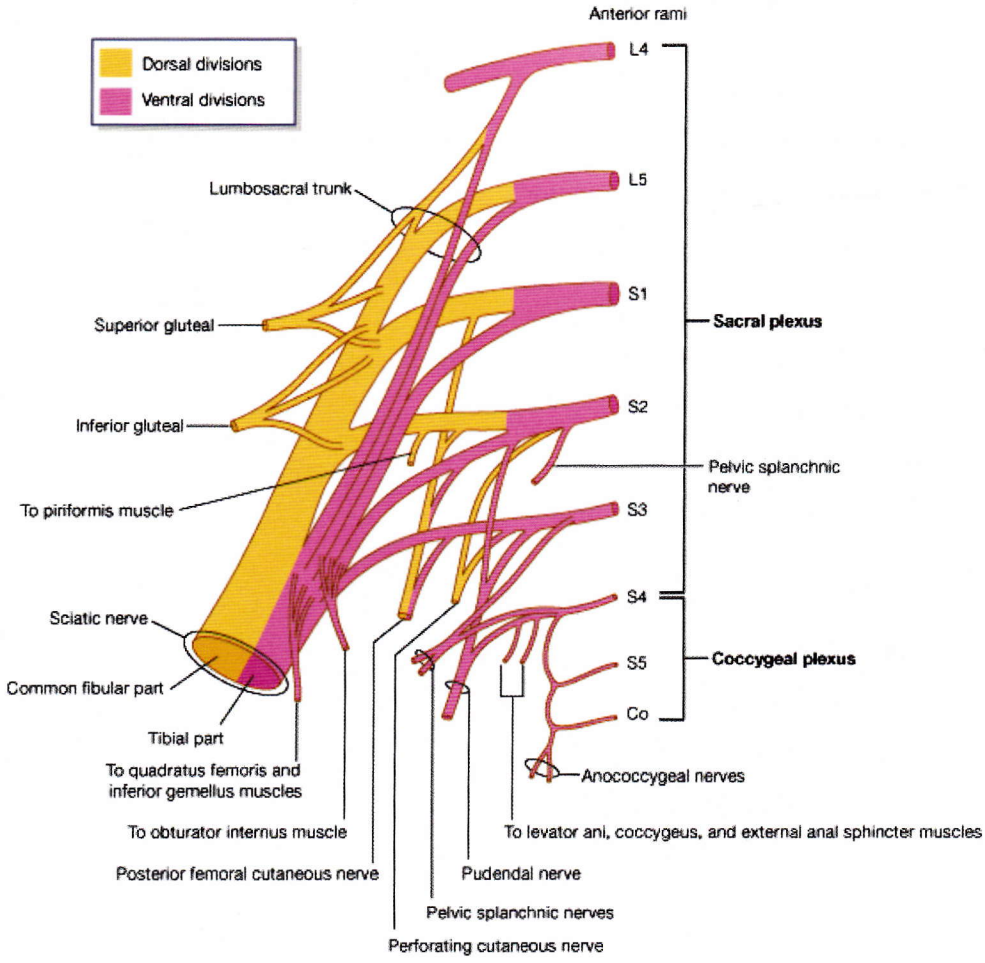
- It is formed by ventral rami of L1, 2, 3 & greater part of L4 (nervus furcalis).
- It is lies within the posterior part of Psoas major muscle.
- Is connected to sacral plexus by lumbo-sacral trunk

Branches: *(Muscular)* MCQ

→ To quadratus lumborum (T12, L1, L2, L3).
→ To psoas minor (L1).
→ To psoas major (L2, L3, L4).
→ To iliacus (L2, L3).
→ Ilio-inguinal (L1).
→ Ilio-hypogastric (L1).
→ Genito-femoral (L1, L2).
→ Lateral cutaneous nerve of the thigh (L2, L3).
→ Femoral (dorsal division of L2, L3, L4).
→ Obturator (venteral division of L2, L3, L4).
→ Accessory obturator (venteral division of L3, L4).







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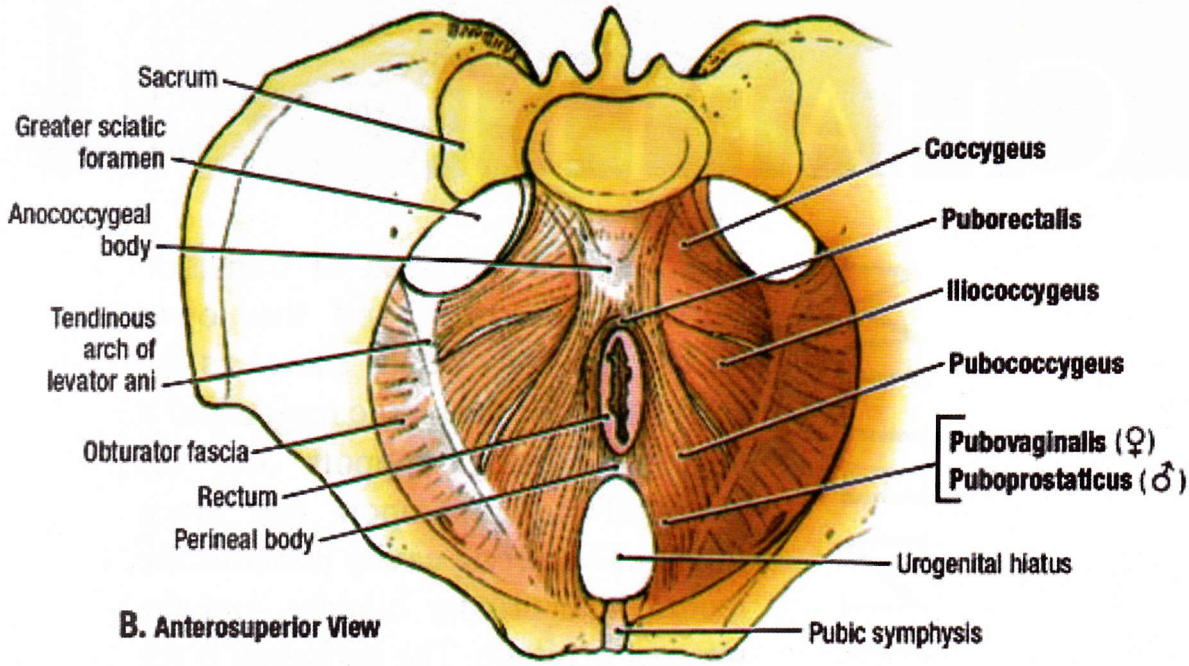
CHAPTER 5

PELVIS & PERINEUM

The pelvis is the area of transition between the trunk and the lower limbs. The bony pelvis serves as the foundation for the pelvic region and it provides strong support for the vertebral column upon the lower limbs. .The pelvic cavity contains the rectum, the urinary bladder, and the internal genitalia. The perineum is the region of the trunk that is located between the thighs. The pelvic diaphragm separates the pelvic cavity from the perineum . The perineum contains the anal canal, the urethra, and the external genitalia (penis and scrotum in the male, vulva in the female).

PELVIS & PERINEUM

Muscles of Pelvic Wall



B. Anterosuperior View

LEVATOR ANI

Origin	*Insertion*	*N Supply*	*Action*
Back of the body of pubis (in front) Inner surface of the ischeal spine (behind) Tendinous arch of obturator fascia (white line)	- *Anterior fibers:* perineal body - *Intermediate fibers:* • At anorectal junction, it continues with its fellow behind the rectum (U-shaped) • This part of the muscle is thickened & blends with the wall of the rectum & is called puborectalis - *Posterior fibers:* last 2 segments of the coccyx	Upper or pelvic surface: from 4th sacral nerve Lower or perineal surface: from the inferior rectal nerve	Both muscles acting together: ↑ intraabdominal pressure Puborectalis: supports the external anal sphincter Anterior fibers: support the prostate in male & acts as a sphincter for vagina in the female

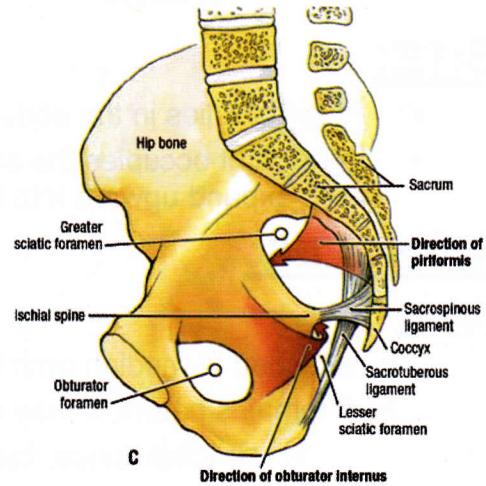
COCCYGEUS:

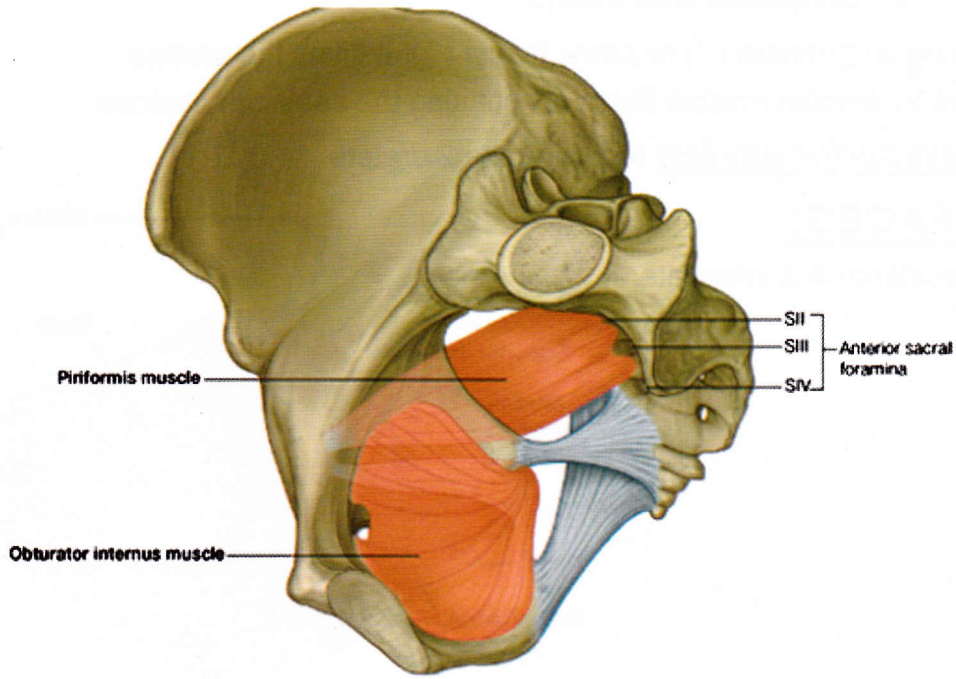
Origin	Insertion	N Supply	Action
Tip of the ischeal spine	Sides of last sacral segment & 1st segment of coccyx	4th & 5th sacral nerves	Supports the pelvic cavity & the coccyx

PIRIFORMIS See lower limb muscles.

OBTURATOR INTERNUS

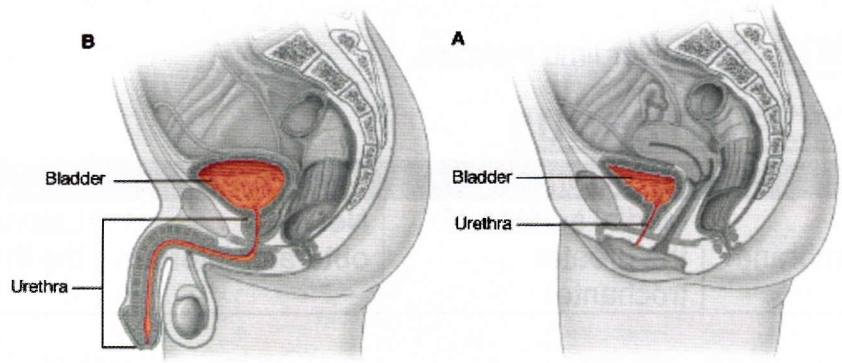
Origin	Insertion	N Supply	Action
Pelvic wall & obturator membrane	Medial surface of the greater trochanter	Nerve to obturator internus	Lateral rotation of the thigh





PELVIC ORGANS

Urinary Bladder



SITE:

- At birth: it lies in the abdominal cavity (Pelviabdominal organ)
- In adult: it occupies the anterior part of the pelvis (Pelvic organ), when it is full it expand upward into the abdominal cavity.

4 ANGLES:

Apex:

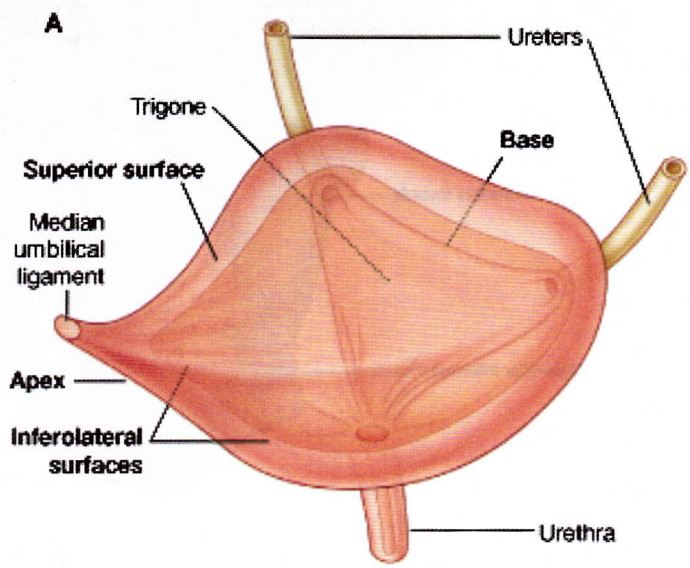
- attached to median umbilical ligament.
- If remains patent, it may cause:
  - Urachal (sinus, fistula, cyst)
  - Congenital diverticulum

Neck: Lying on prostate (♂) or pelvic fascia (♀), it gives the urethra
Surrounded by smooth muscle fibers constituting the sphincter vesicae

MCQ ***2 posterosuperior angles:*** receiving the 2 ureters

4 SURFACES:

Superior, posterior & 2 inferolateral

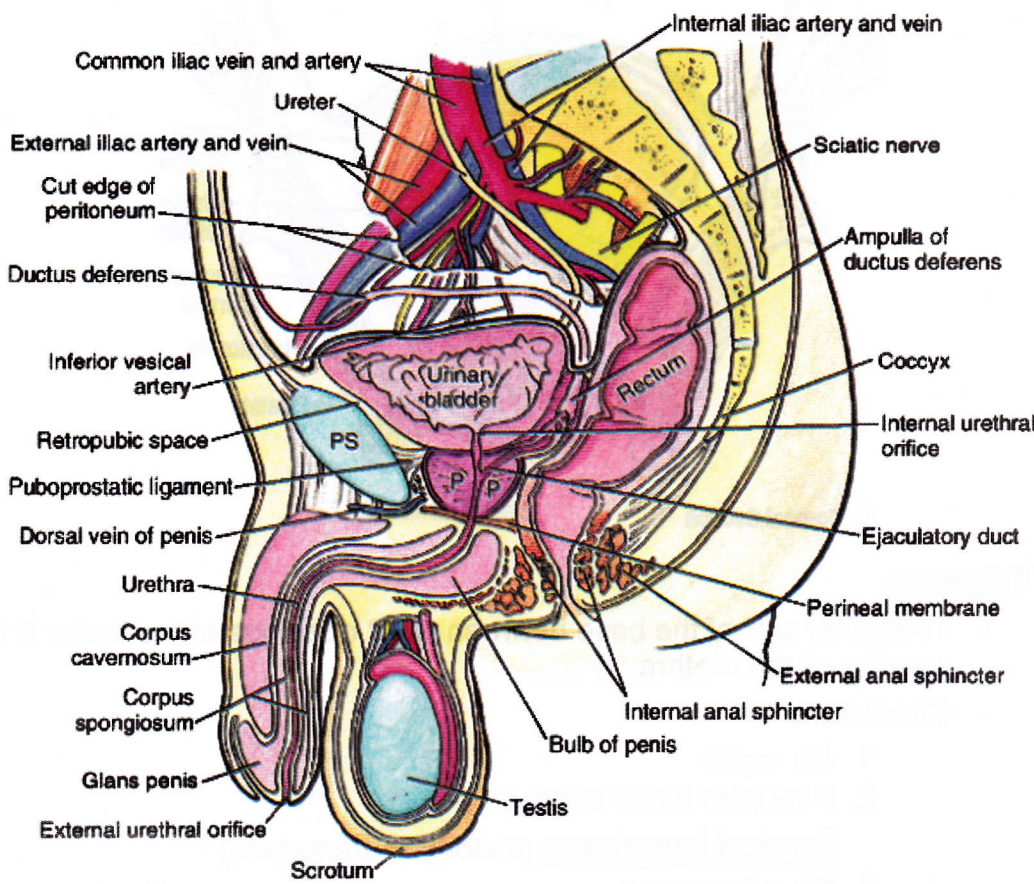


MCQ PERITONEAL COVERING:

Male: superior surface & upper of base. Female: superior surface ONLY.

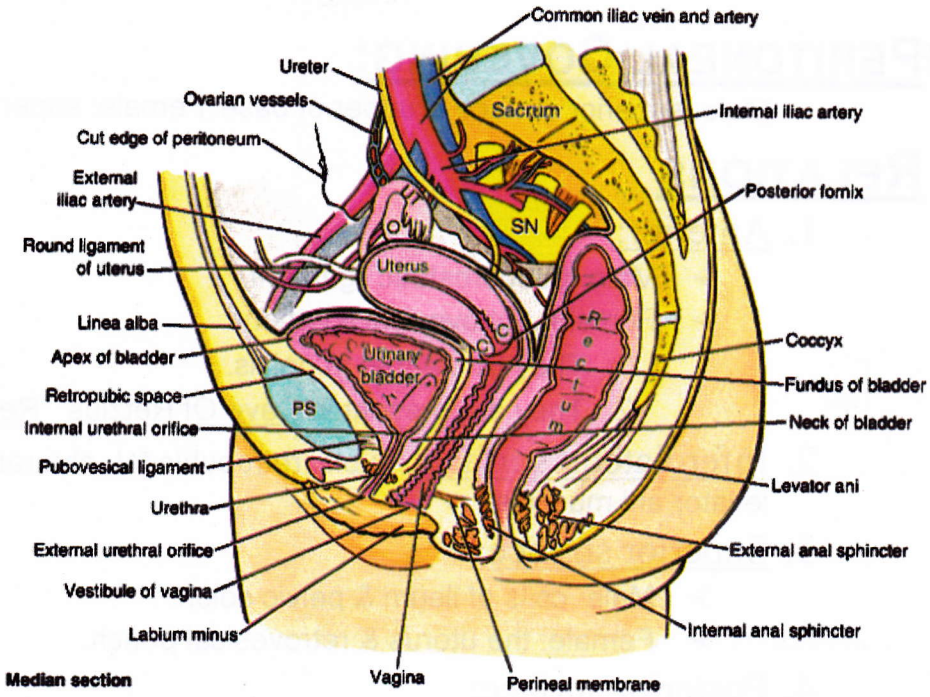
RELATIONS

1. Anterior:
   - Male: puboprostatic ligament.
   - Female: pubovesical ligament.
     1. They fix bladder in pelvis.
     2. They are present in Cave Of Retzius "Retropubic space "
2. Inferolateral surface: pubis, retropubic fat, obturator internus & levator ani muscles.
3. Superior surface:
   - Male: coils of ileum & pelvic colon.
   - Female: the uterus & retrovesical pouch.
4. Posterior surface:
   - Male: 2 seminal vesicles, 2 vasa defferentia & rectum.
   - Female: cervix & vagina.

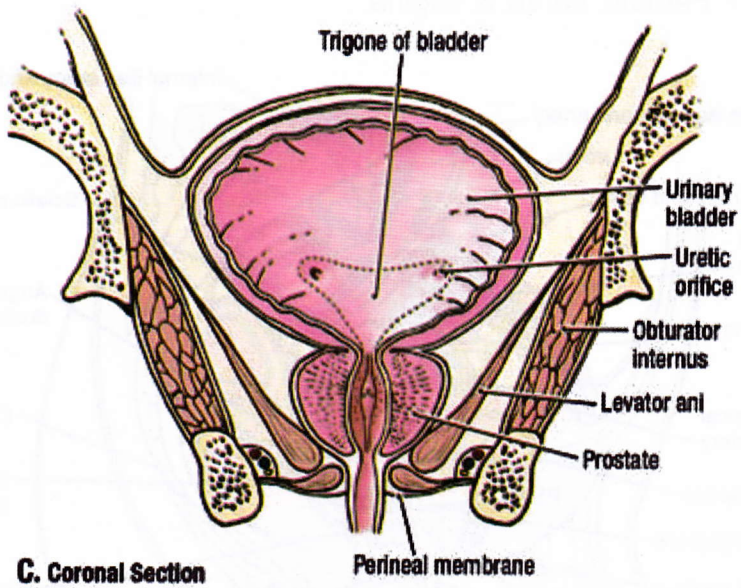


Male

Female



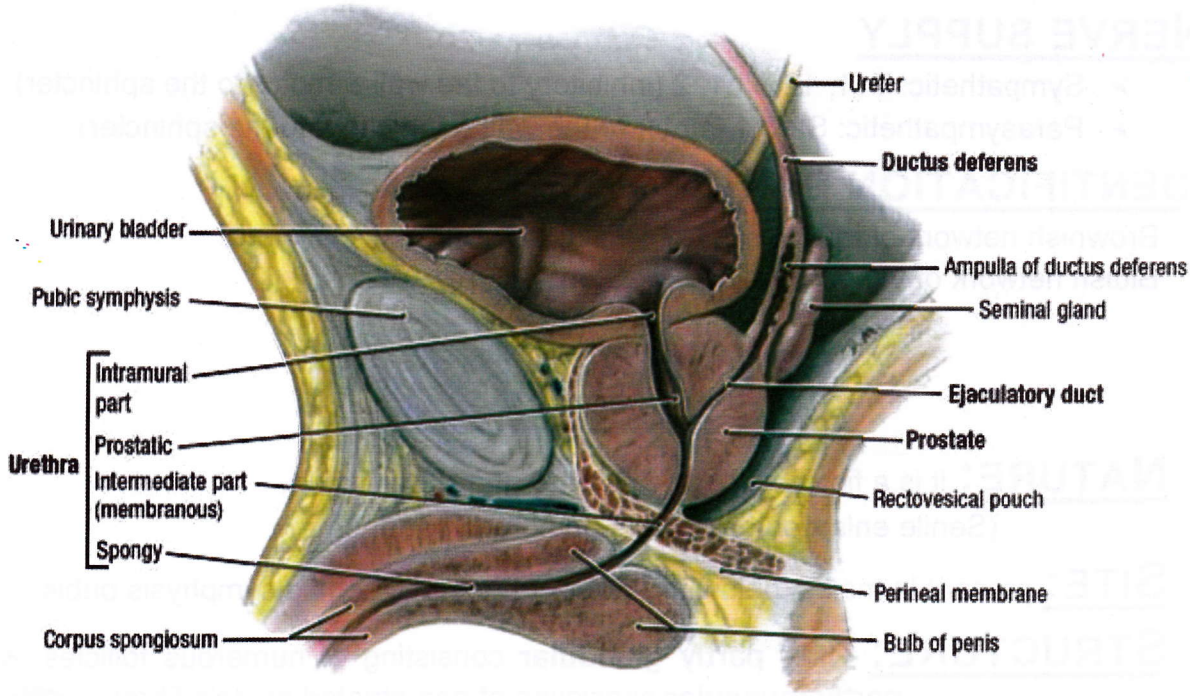
CAVITY OF THE BLADDER



C. Coronal Section

-Trigone:

- Triangular part of the base between the 2 openings of the ureter & the opening of the urethra
- Characters:
  1. No rugae
  2. Pink (rich blood supply)
     Surgical Importance (if stone → hematuria)
  3. No submucosa
     Surgical Importance: → No bilharziasis →No Egyptian cancer
  4. It is richly supplied by nerves
     Surgical Importance: It is more sensitive to pain.



A. Median Section

-Ureteric orifices:

- They lie at the posterolateral angles of the trigone
- The 2 orifices are separated from each other by a transverse ridge called the interureteric crest

-Uvula of the bladder:

- It is produced by the median lobe of the prostate.

  Surgical Importance In old age, the uvula enlarges leading to difficulty to pass urine.

-Internal urethral orifice:

- It is placed at the lowest part of the bladder.
- It is surrounded by an involuntary non-striated muscle forming the sphincter vesicae.

-Intramural part of the ureter:

- The lowermost part of the ureter passes obliquely through the wall of the bladder; this part is called the intramural part.

  Surgical Importance: The oblique course of the intramural part is a factor in preventing regurgitation of urine into the ureter when the bladder is distended.

BLOOD SUPPLY:

MCQ

1) Vesical artries: From internal iliac a.
2) Vesical veins: → internal iliac vein.

   It is connected with vasal, ureteric, prostatic & hemorrhoidal plexus of veins.

LYMPH DRAINAGE:

- Perivesical LN → internal & external iliac LNs → common iliac LNs → para-aortic LNs.

NERVE SUPPLY

- Sympathetic: T11, 12 & L1, 2 (inhibitory to the wall & motor to the sphincter).
- Parasympathetic: S2,3,4 (motor to the wall & inhibitory to the sphincter).

IDENTIFICATION DURING OPERATION

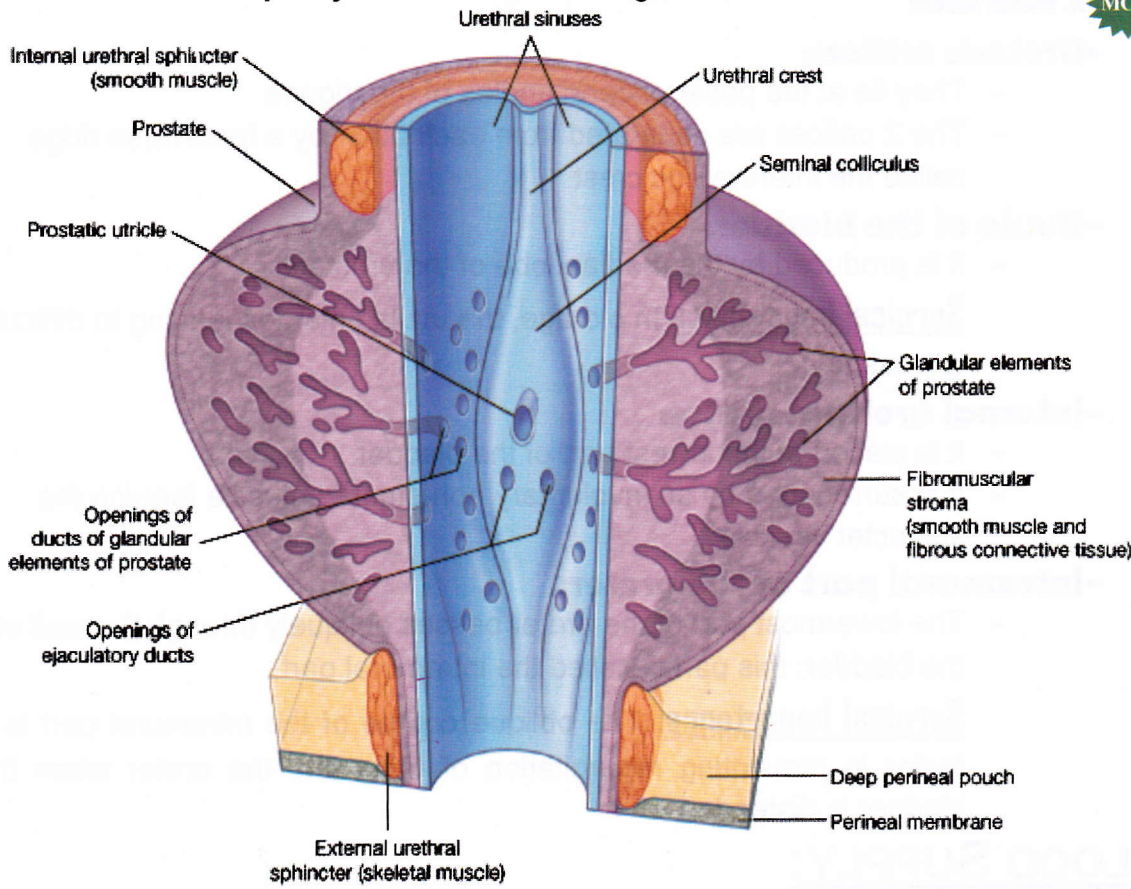
- Brownish network of muscles
- Bluish network of venous plexus
- Fill it with saline → Balloons.
- Stone

Prostate

NATURE: it is a fibromuscular **exocrine glandular** organ.
(Senile enlarged prostate is an fibromyoadenoma)

SITE: present in males, below the bladder neck & is behind symphysis pubis.

STRUCTURE: It is **partly glandular** consisting of numerous follicles, & **partly muscular** consisting of non-striated muscle fibres. MCQ

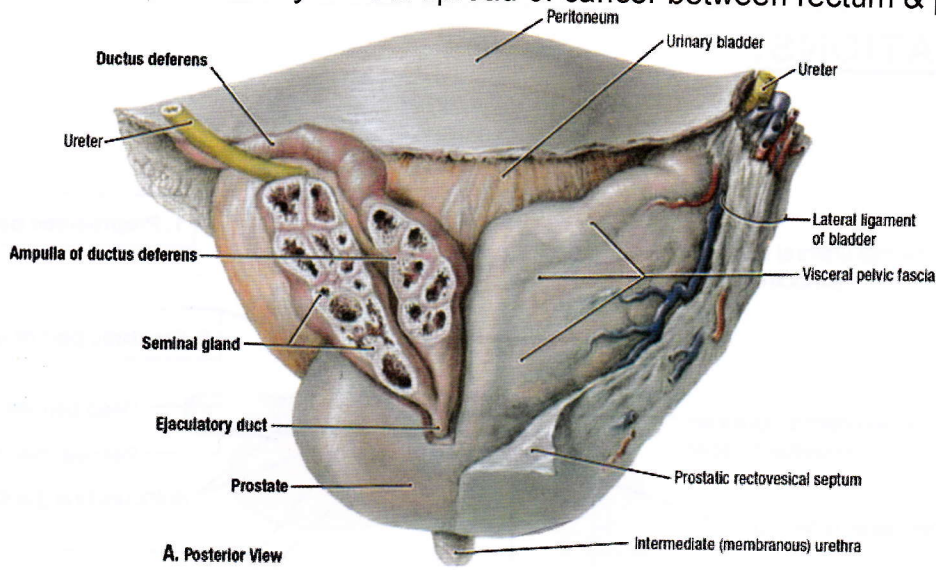


SHAPE:

- It resembles an **inverted cone** with
  - its base directed upwards
  - its apex directed downwards.
  - 4 surfaces : posterior, anterior & 2 inferolateral.
- It weighs 8 gm & measures 4 cm from side to side at the base, & 3 cm from base to apex.

CAPSULES:

- It has a firm fibrous capsule which is adherent to the prostate substance
- ***Inner*** → true fibromuscular capsule.
- ***Outer*** → fascia capsule ***(fascia of Denonvillier)***, which delays direct spread of cancer between rectum & prostate.



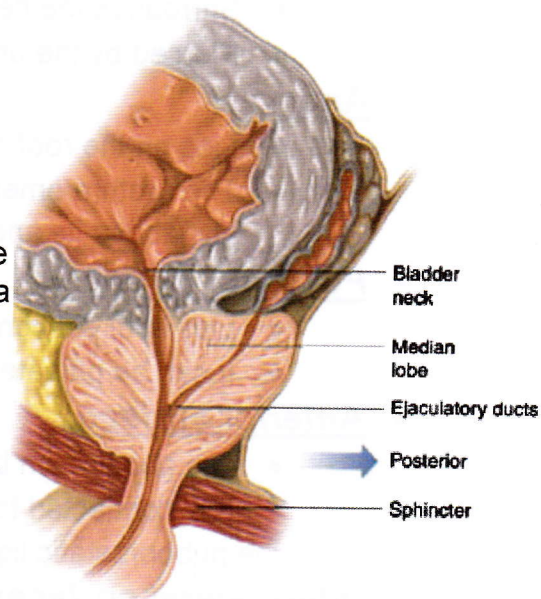
POSITION:

- It ***surrounds*** the prostatic urethra.
- It ***lies behind*** the lower border of symphysis pubis, & in front of the lower part of rectum.
- Its level ***lies*** about 4 cm from the anal orifice →& thus can be palpated by PR examination.

LOBES OF THE PROSTATE:

- By means of prostatic urethra to ejaculatory ducts , the prostate is divided into 5 lobes :

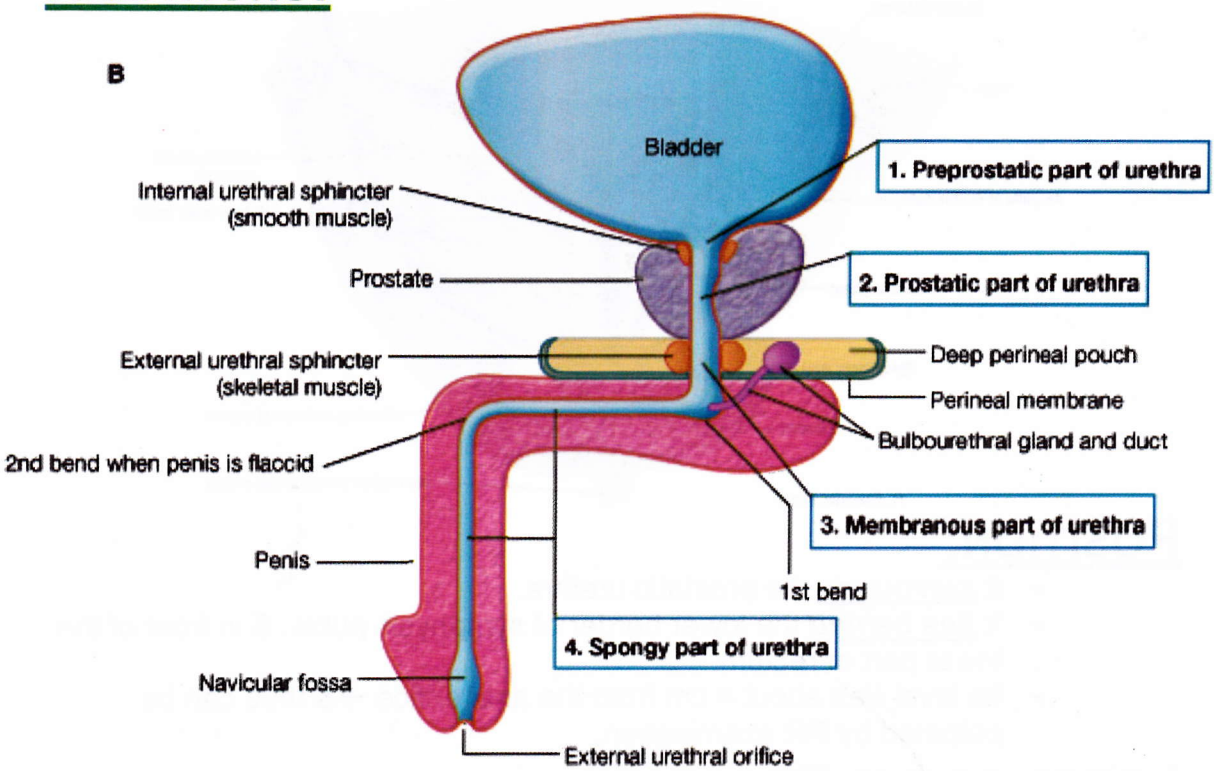
1. Anterior lobe (isthmus) : infront of prostatic urethra , consists of fibromuscular tissue with little glandular tissue
2. , 3. Right and Left Latral lobes : one on each side of the prostatic urethra , they are the usual sites for senile enlarged prostate
4. Posterior lobe : behind prostatic urethra but below the 2 ejaculatory ducts , It is the usual site for cancer prostate .
5. Median lobe :
   - Between the upper part of the prostatic urethra and the 2 ejaculatory ducts
   - After Middle age , it produces " uvula vesicae " in the lower part of the bladder trigone .
   - It is also a common site for senile enlarged prostate.



NB: MCQ

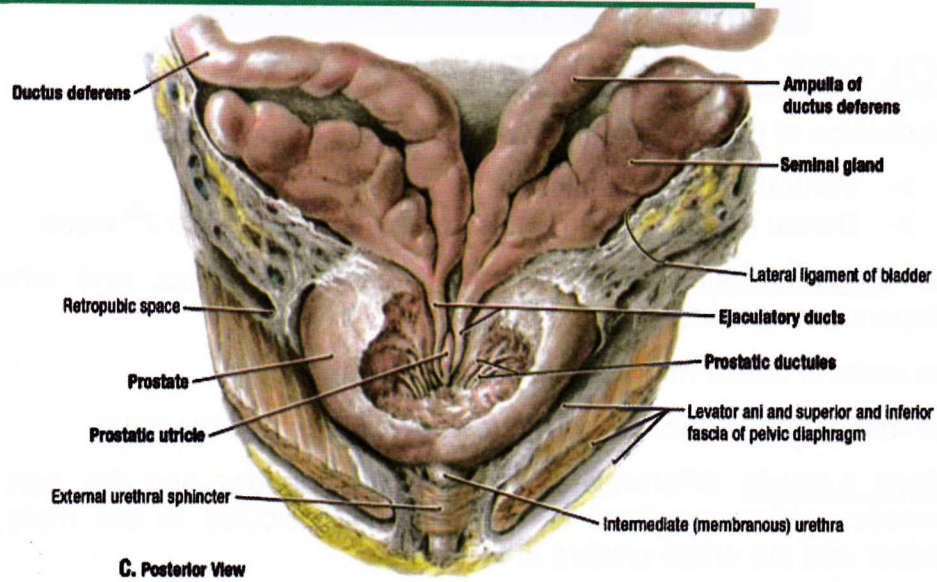
- **The median lobe of the prostate contains more glandular material than the other lobes.**
- **During P/R: only Posterior parts of lateral lobes & Post lobe can be palpated**

RELATIONS:



- ***Base:***
  - Surrounds the neck of the bladder
  - Pierced by the urethra.
- ***Apex:***
  - Lies on the roof of the deep perineal pouch
  - The urethra emerges from the anterior surface of the prostate just above its apex.
- ***Posterior surface:***
  - Lies in direct contact with the lower part of the rectum
  - It can be palpated by PR examination in the living.
- ***Anterior surface:***
  - lies about 2 cm behind the pubic symphysis
  - It is connected to the pubic bones by the puboprostatic ligaments.
- ***Inferolateral surfaces*** (one on each side):
  - Rest on the anterior free borders of the 2 levator ani.
  - The most anterior fibres of the muscles sweep backwards on each side of the prostate to be inserted into the perineal body; these fibres form what is called the levator prostatae.

STRUCTURES WITHIN THE PROSTATE:



1) ***Prostatic urethra:*** traverses the prostate from the base to the apex along the junction of the anterior ⅓ with the posterior ⅔ of the gland.

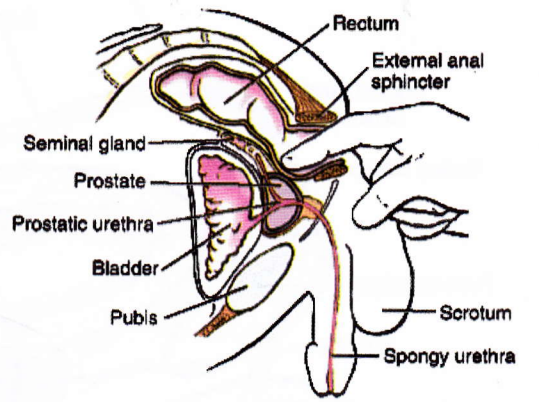
2) ***Ejaculatory ducts:*** the 2 ducts run downwards & forwards one on each side of the median plane to open into the back of the **prostatic urethra**.

MCQ 3) ***Prostatic utricle:*** extends upwards & backwards from the prostatic urethra into the median lobe.

PR EXAMINATION:

The normal prostate is:

Smooth
Soft
Sulci can be felt
Slippery rectal mucosa
Symmetrical



BLOOD SUPPLY:

A) ***Arterial*** → inferior vesical & middle rectal

B) Venous

MCQ
- Prostatic venous plexus of Santorini which lies between the true & the false capsule.
- These are thin walled valveless veins
- It receives the deep dorsal vein of the penis
- It communicates with vesical venous plexus
- It drains into the internal iliac v. which communicates with int. vertebral venous plexus (valveless lateral sacral veins).

SURGICAL IMPORTANCE: Cancer prostate reaches vertebral column rapidly through valveless veins of Bateson

C) Lymphatic drainage:

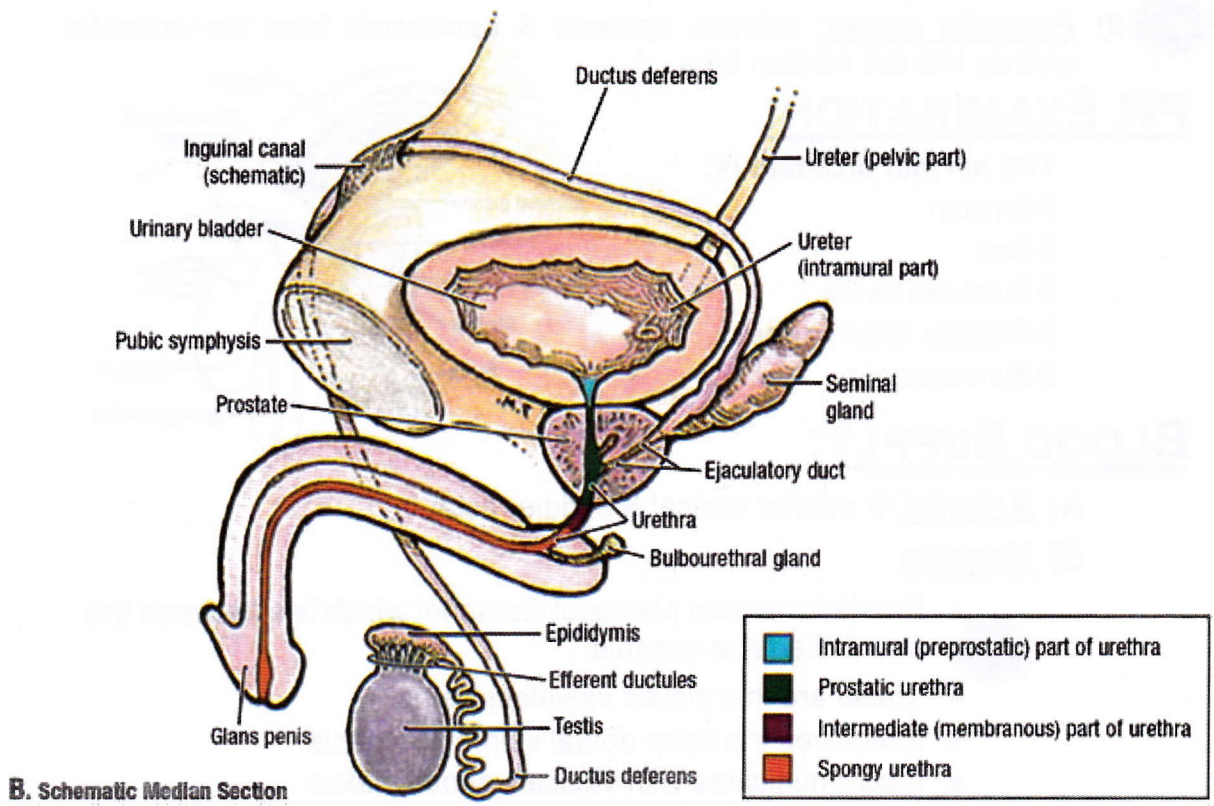
- Internal iliac LNs.

THE URETHRA

EMBRYOLOGY OF URETHRA

- Subdivision of the cloaca (the blind end of the hindgut) into :
  - Ventral (urogenital sinus)
  - Dorsal (rectum) segment is completed during the 7th week
- The urogenital sinus receives the mesonephric duct and which has independent openings.
- The ureteral orifice migrates upwards and laterally.
- The mesonephric duct orifice moves downwards and medially
- Miller's tubercle differentiates to form the bladder and the part of the prostatic urethra proximal to the seminal colliculus in the male or the bladder and the entire urethra in the female
- The rest of the male urethra is formed by fusion of the urethral folds on the ventral surface of the genital tubercle.
- In the female, the genital folds remain separate and form the labia minora.

ANATOMY OF THE URETHRA



B. Schematic Median Section

In the adult male:

- Urethra is 16-20 cm (8 inch) long.
- It is S-shaped.
- It consists of 4 parts :

1) The preprostatic part: (0.5 to 1.5 cm)

2) The Prostatic urethra (1 inch long)

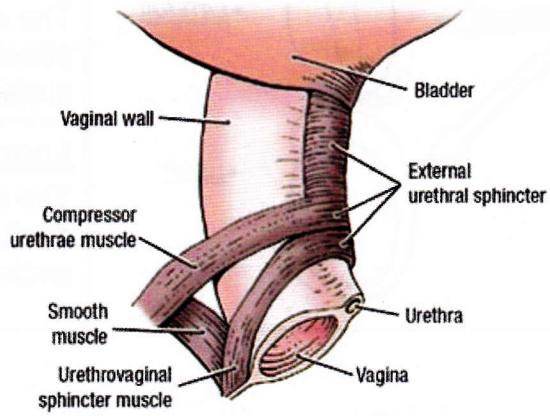
MCQ
- It is heavily muscular & sphincteric
- It is the widest and most dilatable part.
- It receives the ejaculatory duct

3) The Membranous urethra (0.5 inch long) is within the urogenital diaphragm and is surrounded by the striated external sphincter. It is the narrowest and least dilatable part.

MCQ

4) The Penile urethra (6.5" long) is poorly muscularized & traverses the corpus spongiosum to open at the tip of the glans penis.

In the adult female:

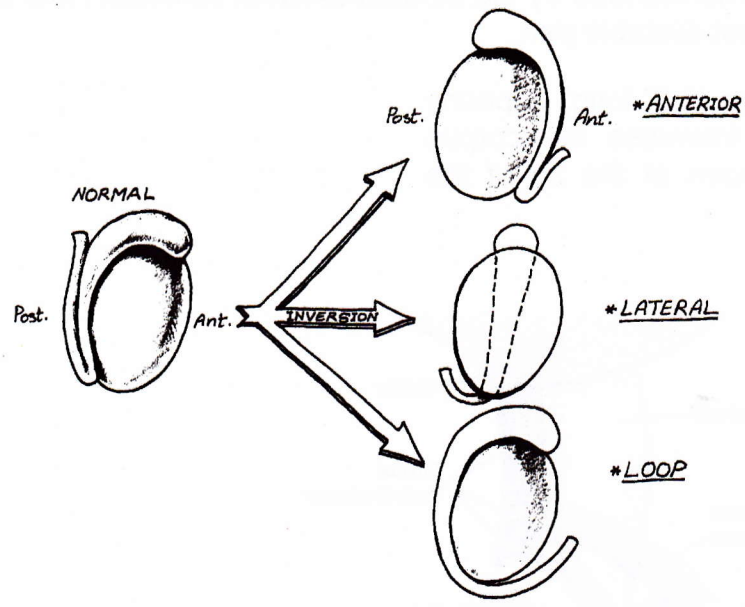


- Urethra is about 4 cm long.
- Begins at bladder neck and ends as the external orifice, in the vaginal vestibule
- Relations :
  1) Anterior: pubovesical ligament.
  2) Posterior : anterior wall of the vagina
- It is muscular in its proximal 4/5.
- The striated external sphincter surrounds the middle third of the urethra.

EPIDIDYMIS MCQ

Normally, Epididymis is attached to posterior border of the testis (Posterolateral).

Inversion of the testis means alteration of the normal position of the axis. it might be:



Anterior inversion

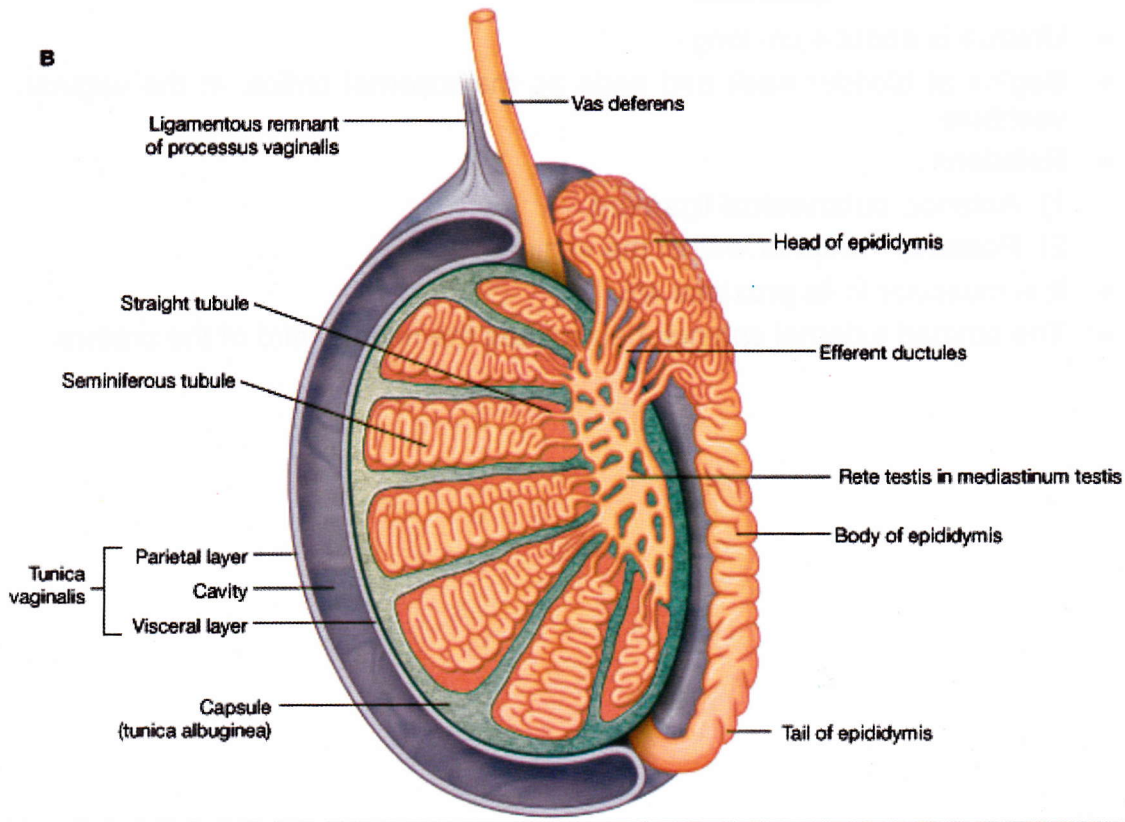
The epididymis is attached to the anterior border (TB sinus can open anteriorly in this case only).

Lateral inversion

The epididymis is attached to the lateral surface of the testis.

Loop inversion

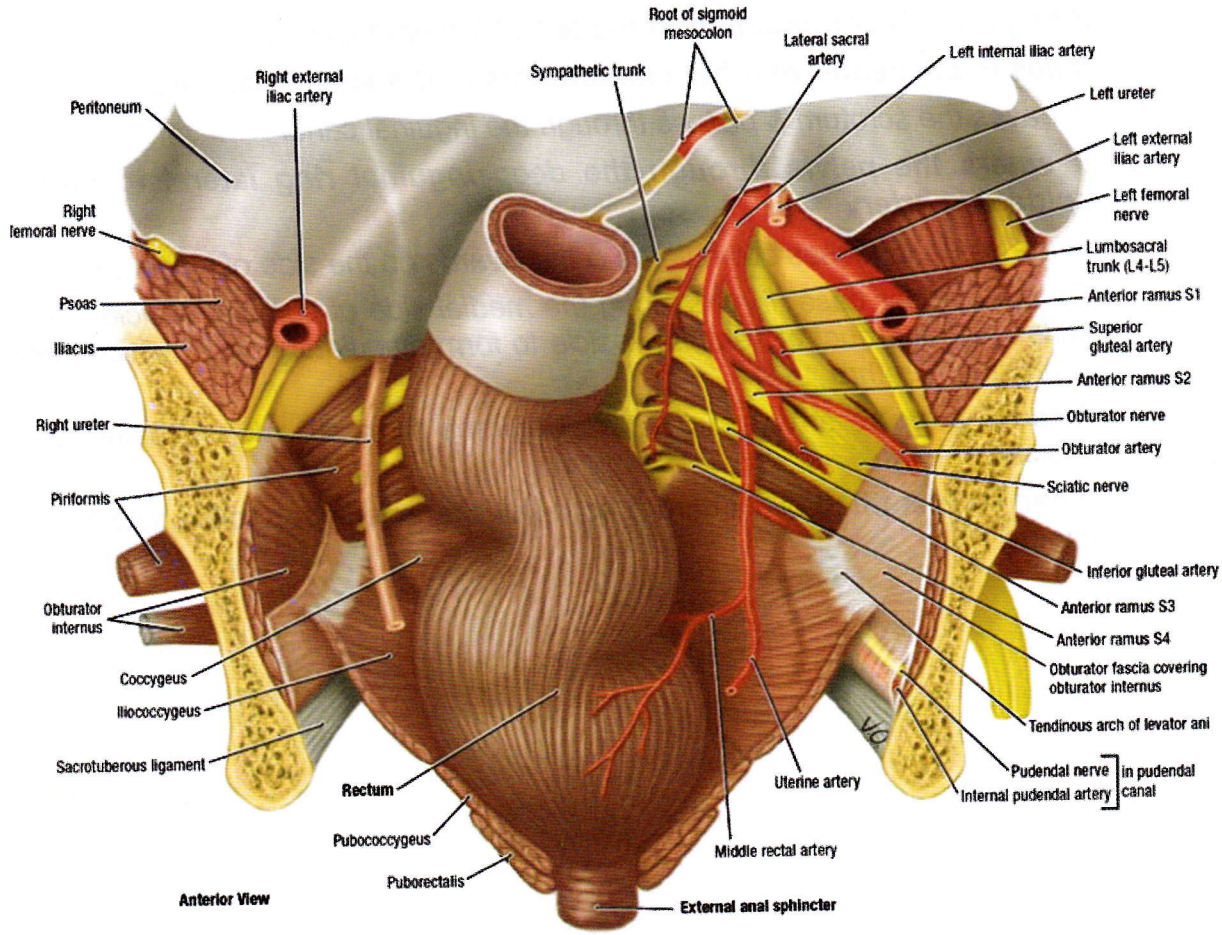
The epididymis & ductus deferens encircle the testis



VAS (DUCTUS) DEFERENS MCQ

- *It is a cord-like duct 45 cm long.*
- ***It begins as a continuation of the tail of the epididymis***
- ***It lies in the center of other constituents of the spermatic cord***
- *It leaves the scrotum & passes through the inguinal canal*
- ***It enters the pelvis through the deep inguinal ring lateral to inferior epigastric artery***
- *In the pelvis it passes downwards & backwards on the side of lesser pelvis*
- *On the bladder base, it runs along the medial side of seminal vesicle, then it unites with the duct of seminal vesicle to form ejaculatory duct , which opens in prostatic urethra*
- ***Arterial supply:*** *artery of the vas deferens form superior (usually) or inf vesical arteries.*
- **It can be identified** by its hard & cord-like character when rolled between the fingers

The Rectum



BEGINS: opposite to S3 as the continuation of sigmoid colon MCQ

ENDS: 1 inch below & in front of the coccyx by bending sharply backwards & downwards to form the anal canal (at the level of pelvic diaphragm)

LENGTH: 5 inches (12.5 cm) MCQ

SHAPE:

- ***Antroposteriorly:*** Concave anteriorly because it follows the concavity of the sacrum.
- ***Side to side:*** Concave 1st to Rt then to Lt then to Rt agin. Opposite to site bending, the mucosa forms mucosal folds which are called **valves of Houston**.
- ***Ampulla of the rectum:*** The dilated lower part. It rests on the pelvic diaphragm (commonest site for cancer rectum in Egypt)

N.B:

MCQ

- Rectum has NO appendices epiploicae
- Rectum has NO teniae coli (teniae coli are nothing but longitudinal muscle fibers).

PERITONEUM: *it is a retroperitoneal structure*

MCQ
- Upper third → front & side.
- Middle third → front.
- Lower third → no (so no transcelomic implantation).

FASCIA AROUND THE RECTUM

Lateral ligament:

From the 3rd sacral piece to the sides of the rectum containing the middle rectal vessels, nervi erigentes ($S_{2,3}$).

MCQ
Fascia of Waldeyer:

Posterior to the rectum (behind the fascia there is the presacral venous plexus).

MCQ
Fascia of Denonvilliers:

Anterior to the rectum (attached to the prostate).

SURGICAL IMPORTANCE: delays the spread of cancer

SUPPORTS OF THE RECTUM

1) Attachment of the levator ani between the external & internal sphincters.
2) The fascia around the rectum.
3) The rectouretheralis muscle.
4) The fatty tissue of the pelvis & ischiorectal fossa.
5) The sacral curve.

RELATIONS:

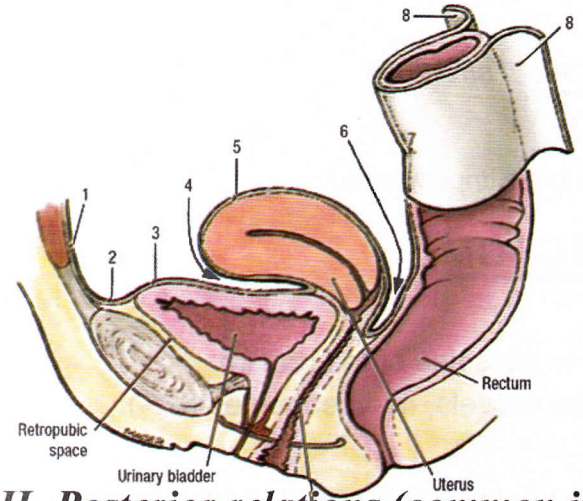
I- Anterior relations:

In Males:

MCQ
- Upper 2/3: Coils of ileum & sigmoid colon (*in the rectovesical pouch*)
- Lower 1/3:
  - Base of the bladder and related structures :
    - 2 seminal vesicles.
    - 2 vas deferens
    - The terminal parts of the 2 ureters.
  - Prostate

In Females:

- Upper 2/3:
  - Coils of ileum & sigmoid colon (*in the Douglas pouch*)
  - Uterus and upper part of the vagina (separated from the rectum by the rectouterine pouch).
- Lower 1/3: Lower part of the vagina (no peritoneum inbetween).



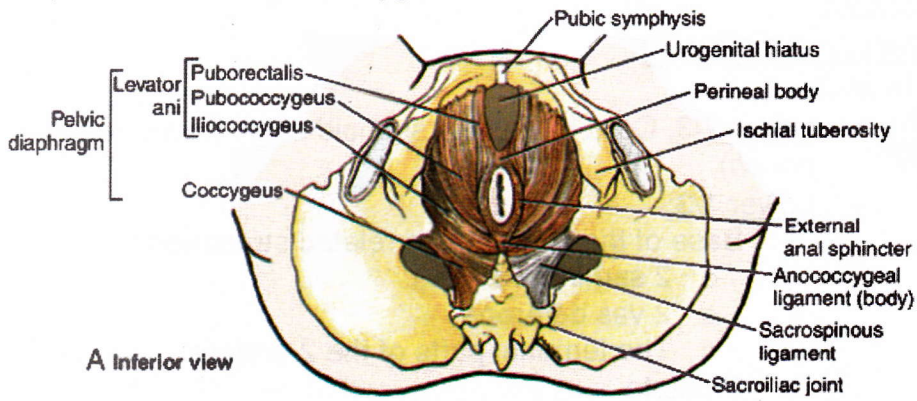
Female:
Peritoneum passes:
- From the anterior abdominal wall *(1)*
- Superior to the pubic bone *(2)*
- On the superior surface of the urinary bladder *(3)*
- From the bladder to the uterus, forming the vesicouterine pouch *(4)*
- On the fundus and body of the uterus, posterior fornix, and all of the vagina *(5)*
- Between the rectum and uterus, forming the rectouterine pouch *(6)*
- On the anterior and lateral sides of the rectum *(7)*
- Posteriorly to become the sigmoid mesocolon *(8)*

II- Posterior relations (common in ♀ & ♂)

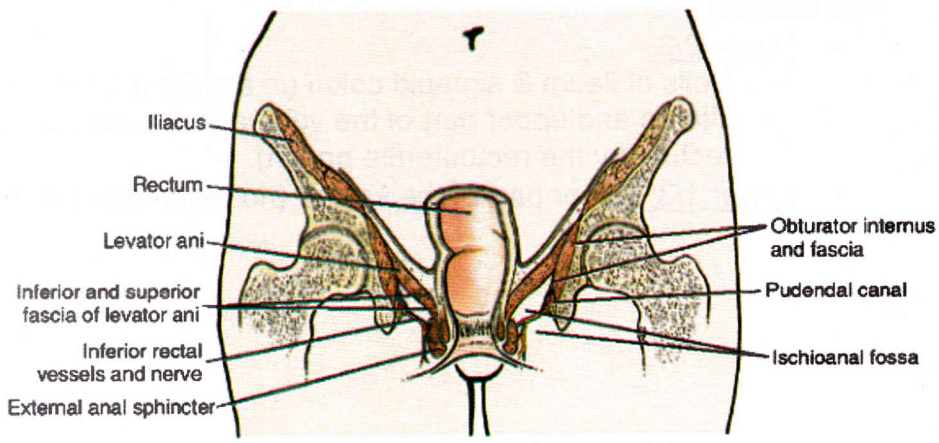
- ***3 Bones & Ligaments:*** lower ½ of the sacrum, coccyx & anococcygeal ligament.
- MCQ ***3Muscles:;*** Piriformis, coccygeus & levator ani (of both sides → in front of midline raphe).
- ***3 Vessels***: Median sacral, lateral sacral & superior rectal vs
- MCQ ***3 Nerves:***
  1) The 2 sympathetic trunks and the ganglion impar.
  2) Lower 3 sacral nerves.
  3) Coccygeal nerves.

III- On each side (common in ♀ & ♂):

1) Pararectal fossa with its content of sigmoid colon or ileum.
2) Inferior hypogastric plexus.
3) Levator ani and coccygeus muscles.



A Inferior view



B Coronal section

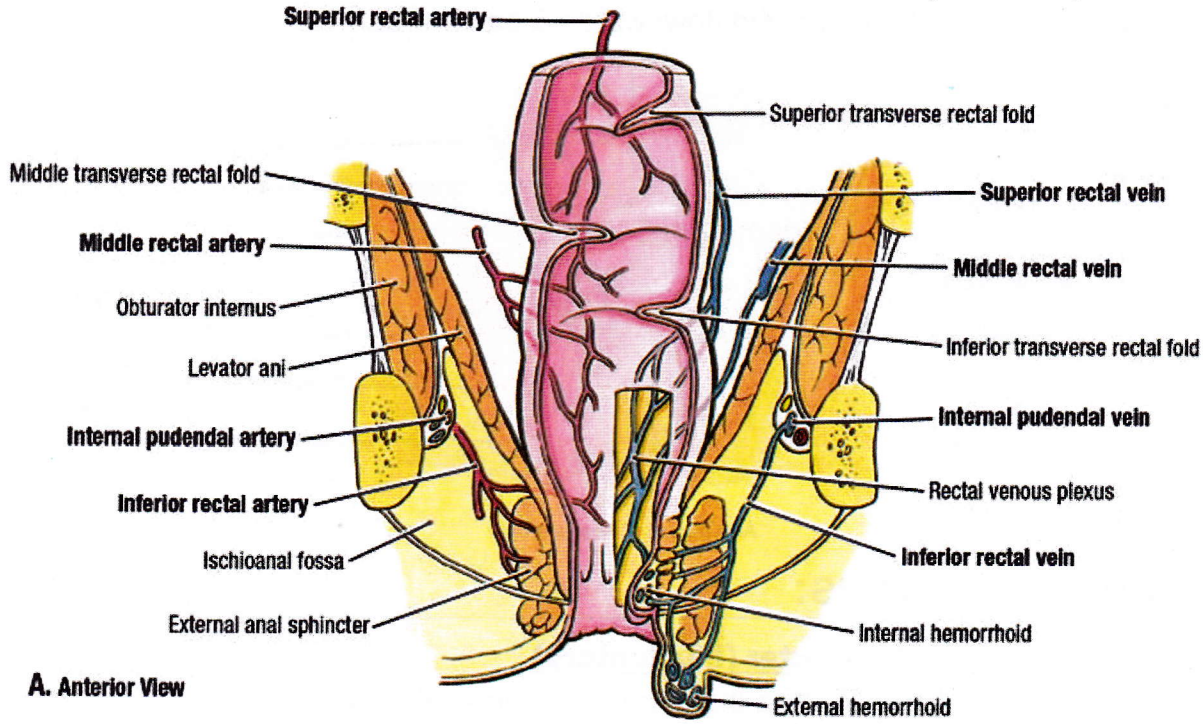
BLOOD SUPPLY: MCQ

a- ***Superior rectal artery and vein*** (continuation of inf. mesenteric artery and v.); it gives three branches at 3, 7, 11 O'clock.

SURGICAL IMPORTANCE: Mother piles at these sites.

b- ***Middle rectal artery and vein*** (from int. iliac artery and vein).

c- ***Inferior rectal artery and vein*** (from int. pudendal artery and vein).



A. Anterior View

LYMPH DRAINAGE

- Usually in upward direction.
- Pararectal LNs (2) posterior to the rectum.
- Intermediate LNs along the superior rectal vessels,especially the group which lies just above the levator ani & close to the rectal wall in the region of the ampulla (LNs of Gerota).
- Central node at the Inferior Mesenteric artery (1).
- To a minor extent, some lymphatics pass along the middle rectal vessels → Internal Iliac LNs (3).

SURGICAL IMPORTANCE:

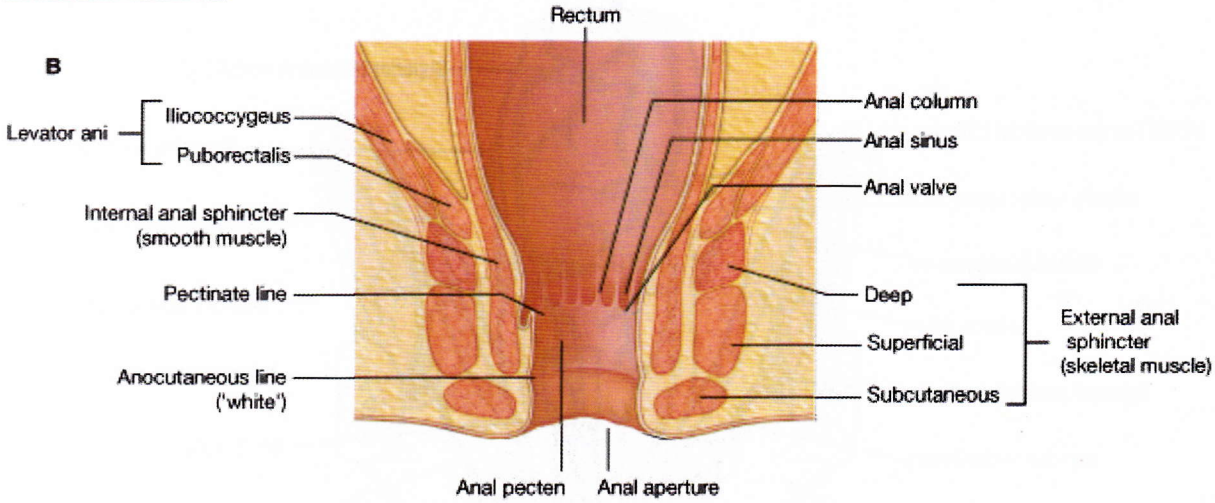
Lymphatics mainly drain upwards so, removal of 2 cm below the tumour is enough in cancer rectum.

ANAL CANAL

BEGINS as a continuation of the rectum 1 inch below & in front of the tip of coccyx

ENDS at anal verge (sunray appearance due to corrugator cutis ani muscle)

LENGTH 4 cm directed downwards & backwards.



ANAL SPHINCTERS:

A- Internal sphincter (involuntary)

- It surrounds the upper ¾ of the anal canal
- It is the lower border of the inner circular muscles
- Nerve supply → Autonomic.
- It is involuntary (smooth muscle) → White color

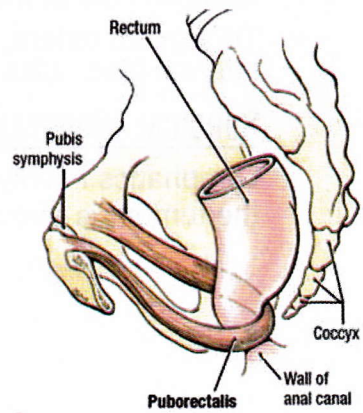
Surgical importance:

- It shows spasm in any painful anal condition (e.g. anal fissure)
- Its division (sphincterotomy) removes the spasm & pain and improves the drainage without bad effects

MCQ

B- External Sphincter (voluntary)

- It is voluntary (striated muscle).
- Formed of 3 parts
  - a- **Subcutaneous** → Ring
  - b- **Superficial** → Elliptical & attached to the coccyx
  - c- **Deep** → Ring, together with the puborectalis → form the anal ring



- ***Nerve supply***: Somatic nerve (Inferior rectal n. → branch from pudendal nerve).

Muscular Ring at Rectoanal junction by fusion of :

1) Internal sphincter.
2) Deep external sphincter.
3) Puborectalis except anteriorly.

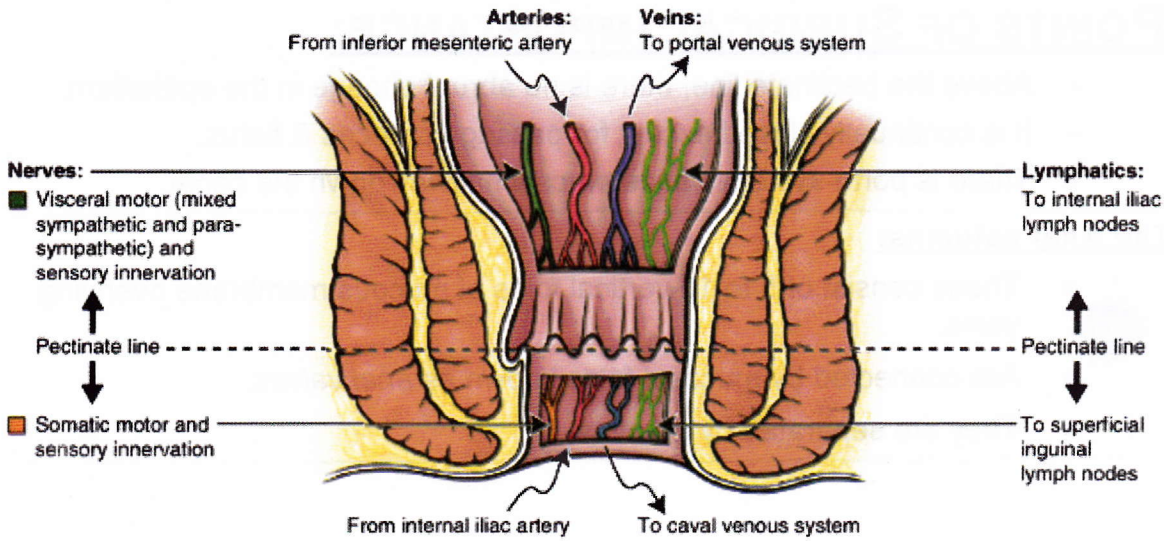
Surgical importance:

Damage of this ring results in incontinence (it must be protected during the removal of fistulous track)

RELATIONS: See above (Relations of the rectum).

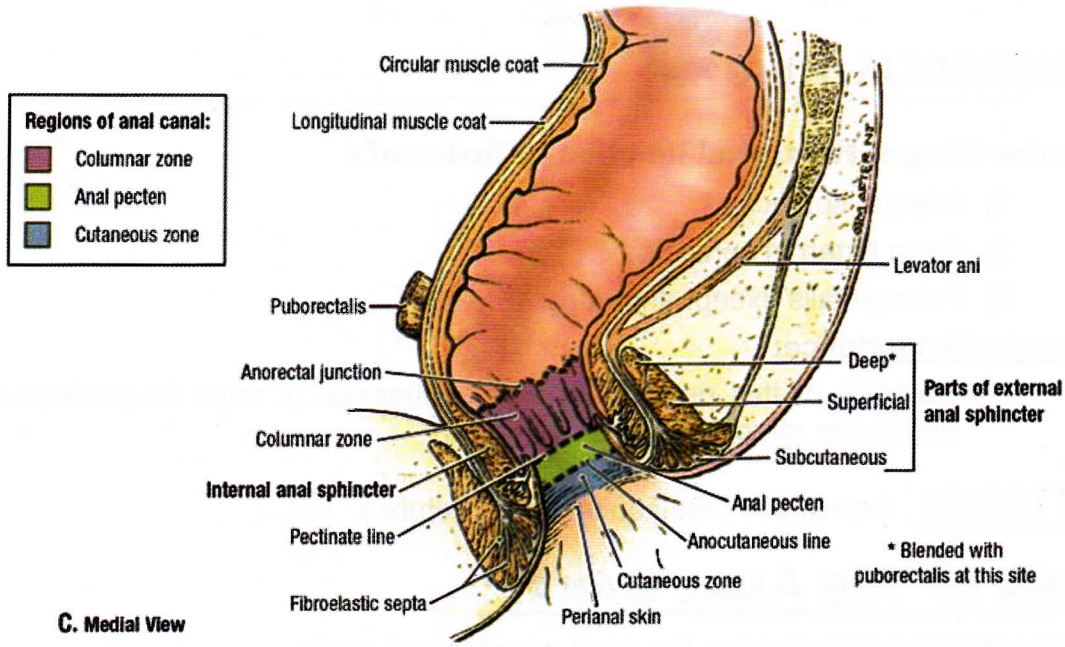
MUCOSA OF THE ANAL CANAL:

Dentate (Pectinate) line divides the anal canal into 2 parts



Separation of "visceral" and "parietal" at the pectinate line

	Above Dentate line	*Below Dentate line*
Derived from	Endoderm	Proctodeum = ectoderm
Lining	Simple columnar	Pecten & skin (stratified squamous epithelium)
Nerve supply	Autonomic	Sensory
Blood supply	Superior rectal vessels (portal)	Middle & inferior rectal vessels (systemic)
Lymph drainage	Internal iliac LNs	Superficial inguinal LNs
Columns of Morgagni (elevated mucosa)	Present	Absent



POINTS OF SURGICAL IMPORTANCE:

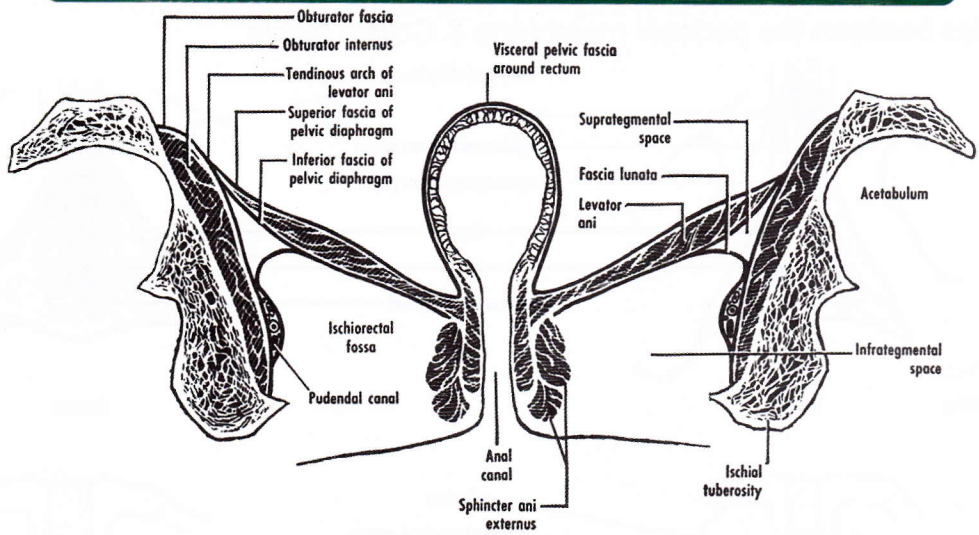
- Above the pectinate line, there is no abrupt change in the epithelium.
- It is continually closed except for passage of feces & flatus.
- There is porto-systemic anastomosis halfway down the canal.

The Anal columns:

MCQ

- These consist of 5 to 10 vertical folds of mucous membrane overlying veins.
- Are connected by mucosal folds known as *anal valves*.
- They are separated by grooves.

Ischiorectal Fossa



This is a wedge shaped space situated on either side of the anal canal.

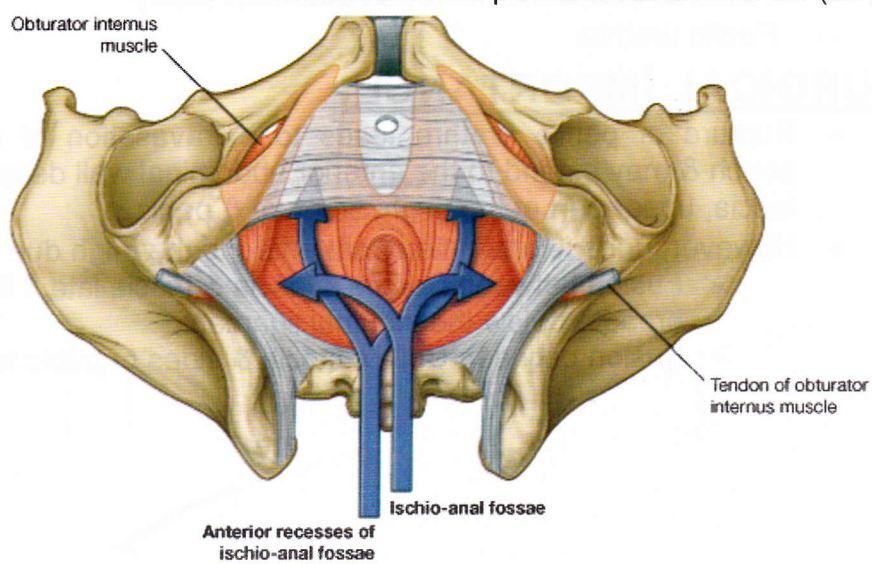
MCQ

BOUNDARIES:

- **Apex:** white line directed upwards, meeting of lateral & medial walls
- **Base:** directed downwards, formed by perineal skin & fascia on either sides of the anal orifice
- **Anterior wall:** lower part of deep perineal pouch
- **Posterior wall:** sacrotuberous ligament
- **Medial wall:** lower surface of levator ani and external anal sphinctre
- **Lateral wall:** obturator internus muscle and ischial tuberosity

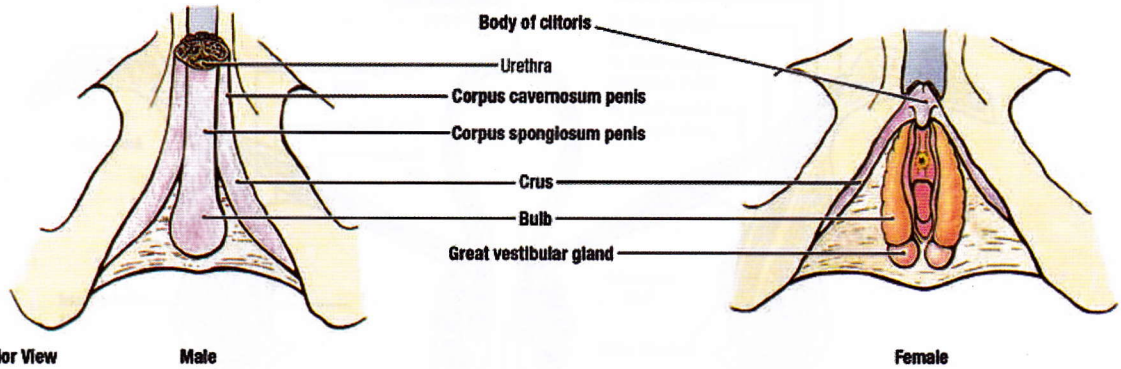
CONTENTS:

- Large pad of fat
- Alcock's(pudendal) canal
- pudendal n. & internal pudendal vessels + their branches :
  - 2 labial or scrotal branches
  - Inferior rectal nerve and vessles
  - Perineal br. And perineal cautenous br. (S_2 , S_3)

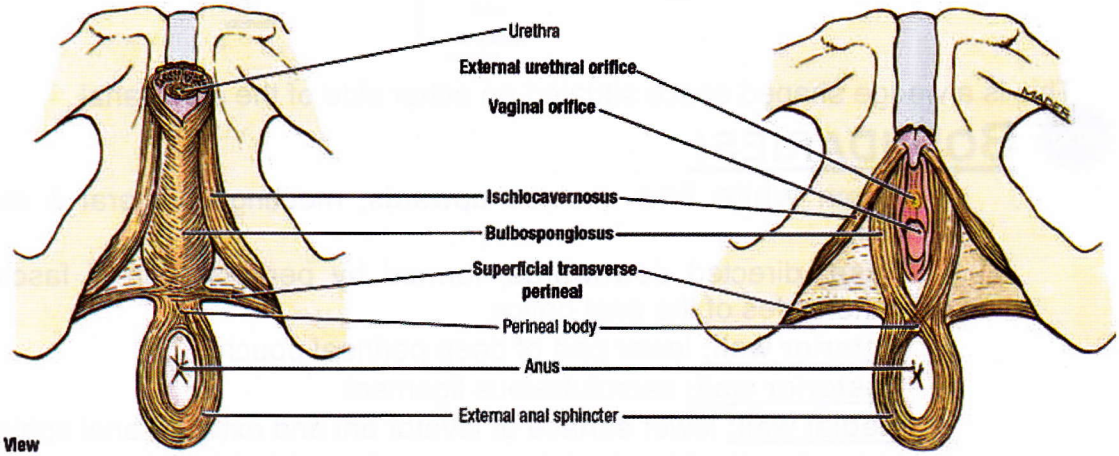


Superficial Perineal Pouch

MCQ Lies between the perineal membrane & Colle's fascia



D. Inferior View — Male — Female



E. Inferior View

MCQ

CONTENTS:

- **Root of the penis (or clitoris)**
- Superficial perineal muscles
- Posterior scrotal (or labial) nerves & arteries
- Dorsal nerve of the penis
- Deep dorsal vein of the penis
- Terminal branches of internal pudendal artery
- Penile urethra

MCQ

SURGICAL IMPORTANCE:

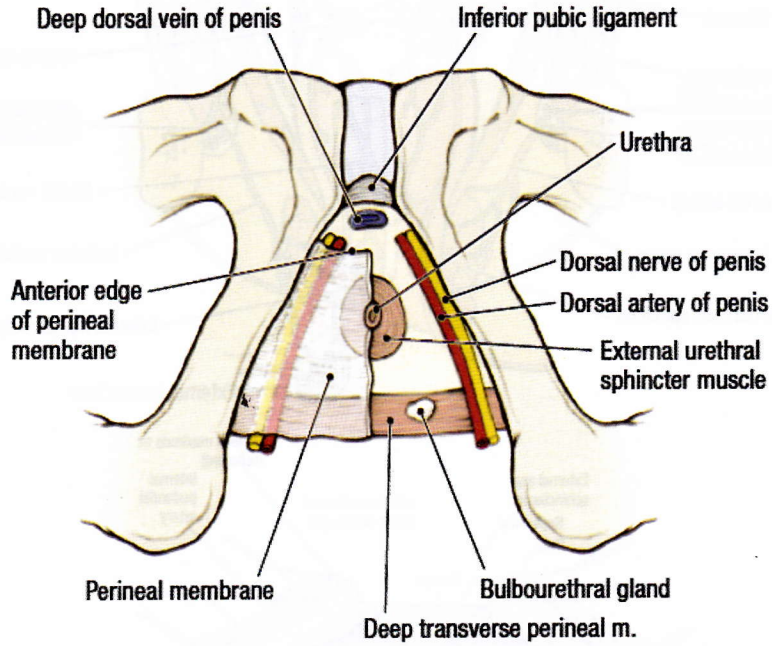
- Rupture of penile urethra leads to extravasation of urine in the pouch & may extend to the anterior abdominal wall deep to Scarpa's fascia, upper part of the thigh, scrotum & penis
- However, urine is prevented from entering the thigh due to:
  - Fusion between Scarpa's fascia & fascia lata 1 finger breadth below the inguinal ligament.
  - Fusion between Colle's fascia & sides of pubic arch

Deep Perineal Pouch

It is a closed space , Lies between perineal membrane & urogenital diaphragm

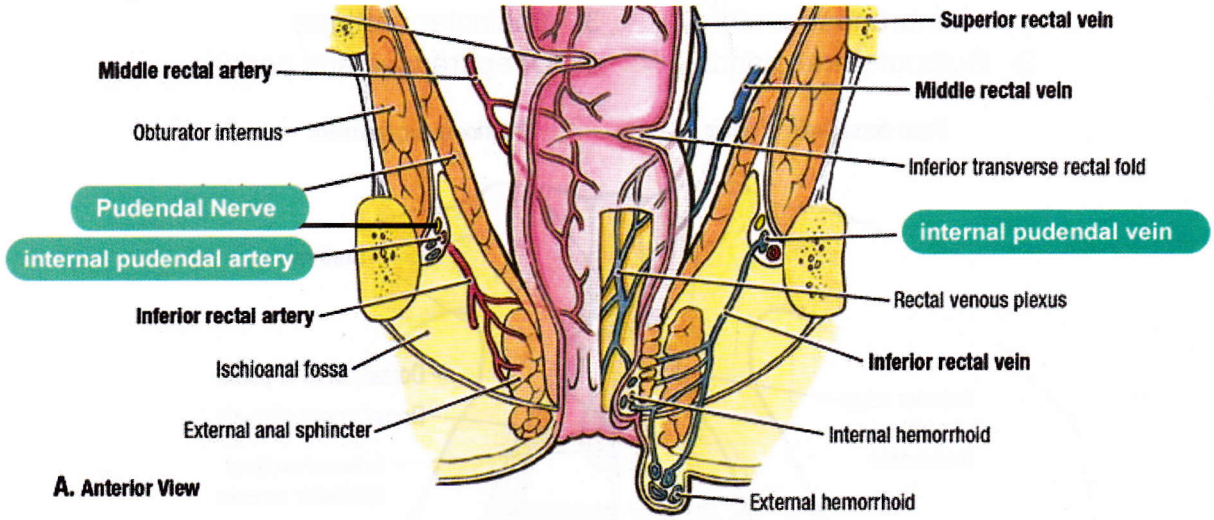
CONTENTS:

1- Membranous urethra
2- Bulbourethral glands
3- Sphincter urethrae
4- Deep transversus perinea

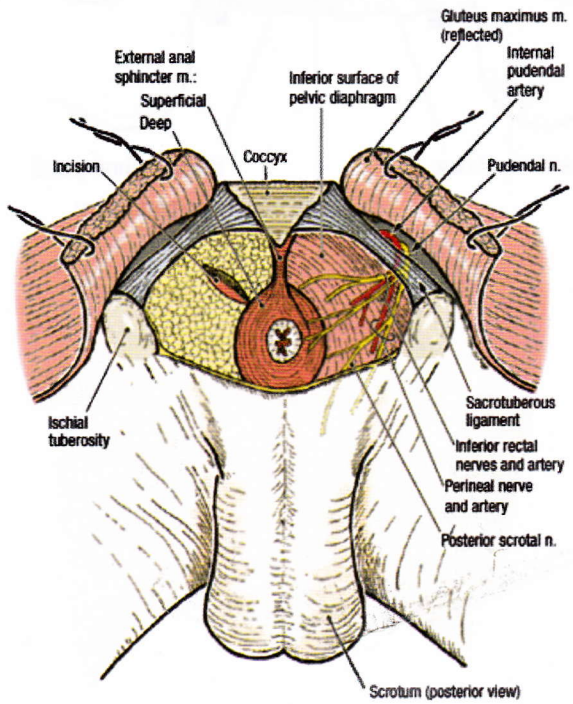


Pudendal canal

" Alcock's Canal "

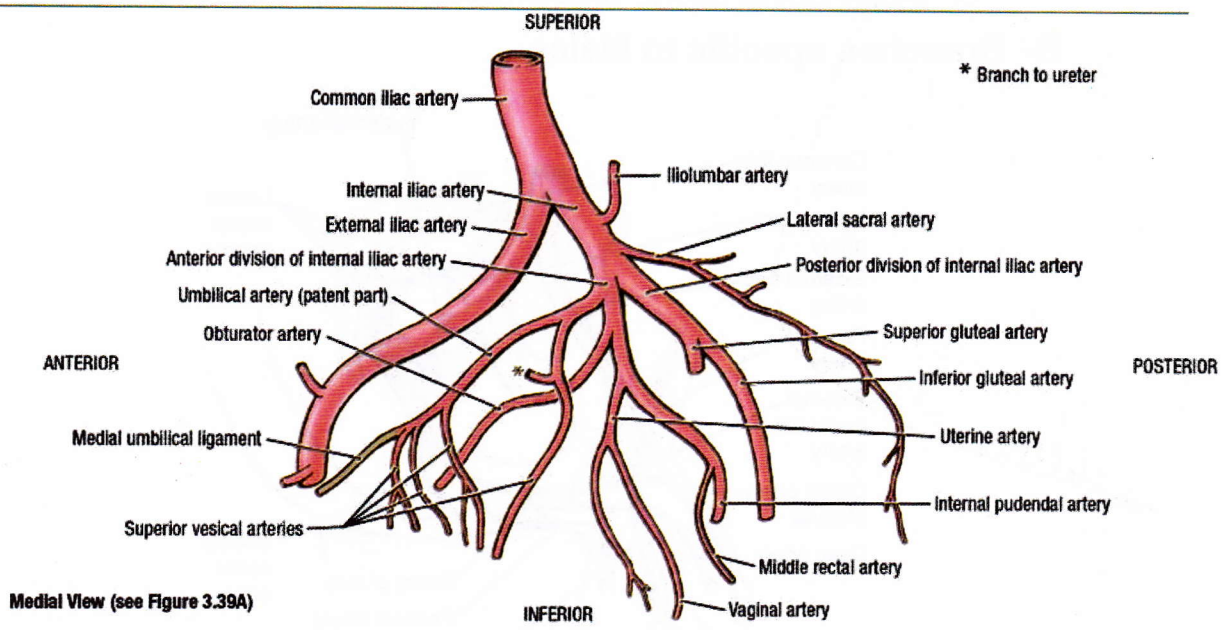


A. Anterior View



Blood vessels of the pelvis

THE INTERNAL ILIAC ARTERY



ORIGIN: At sacroiliac joint as the smaller of the 2 terminal branch of common iliac a.

ENDS:

- In the pelvis near the upper part of the greater sciatic foramen.
- It divides into anterior & posterior divisions which gives the terminal branches

BRANCHES

I. Anterior division:

A- Branches common in ♂ & ♀:

1) *Umbilical artery*

- Gives 2 or 3 superior vesical arteries, then the distal part of becomes fibrosed forming the lateral umbilical lig & reaches the neck of umbilicus.
- **Surgical Importance:** It divides triangle of Hasselbach into medial & lateral parts.

MCQ 2) *Obturator artery*

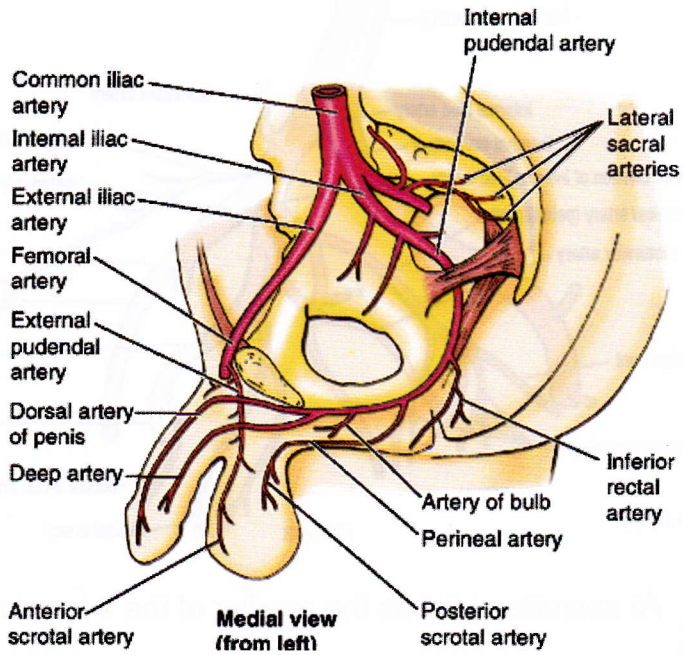
- It passes through the obturator canal & obturator foramen with the obturator nerve
- It divides into posterior & anterior branches
- It distributes largely outside the pelvis & gives an acetabular branch.

Surgical Importance:

- It gives a pubic branch which anastomoses with the pubic branch of inf epigastric a
- Abnormal obturator artery (see above).

3) *Middle Rectal artery:* anastomoses with sup & inf rectal arteries.

B- Branches specific to Males



- *Inferior Vesical artery:* It supplies the seminal vesicles, prostate, urinary bladder & artery of the Vas.

C- Branches specific to Females

- *Vaginal artery:* to the vagina & urinary bladder.
- *Uterine artery:* to the uterus. It anastomoses with the ovarian a.

D- Two terminal branches of anterior division

a. *Inferior gluteal artery (below Piriformis).*
b. *Internal pudendal artery (below Piriformis).*

II. Posterior division

1) Iliolumbar artery: it gives
   - Ileal branch to iliacus muscle.
   - Lumbar branch to quadrates lumborum.
2) Lateral sacral artery (2 branches)
3) Superior gluteal artery (passes through greater sciatic foramen)

N.B.

When internal iliac A. is ligated to control pelvic hemorrhage, ligation doesn't stop the blood flow due to the 3 arterial anastomosis (lumbar to iliolumbar, median sacral to lateral sacral & superior rectal to middle rectal) this maintain blood supply to pelvic viscera, gluteal region & genital organs.

CHAPTER 6

LOWE LIMB

The functional requirements of the lower limb are weight bearing, locomotion, and maintenance of equilibrium. As such, it is constructed for strength at the cost of mobility. The lower limb is divided into four parts: hip, thigh, leg, and foot .

LOWER LIMB

BONES

THE HIP BONE:

Features: It is formed by fusion of 3 bones { Ilium, Pubis, Ischium }

A.**Ilium:** has:

1. Body: forms the upper 2/5 of the acetabulum.
2. 3 borders: anterior, posterior & superior (iliac crest).
3. 3 surfaces: iliac fossa, sacro-pelvic surface & gluteal surface.

B.**Ischium:** has:

1. Body: forms the posterior 2/5 of the acetabulum.
2. Ischial spine: separates the greater sciatic notch from the lesser sciatic notch.
3. Ischial tuberosity: gives origin to the hamstring muscles.
4. Ischial ramus: joins the inferior pubic ramus to form conjoined ischio-pubic ramus.

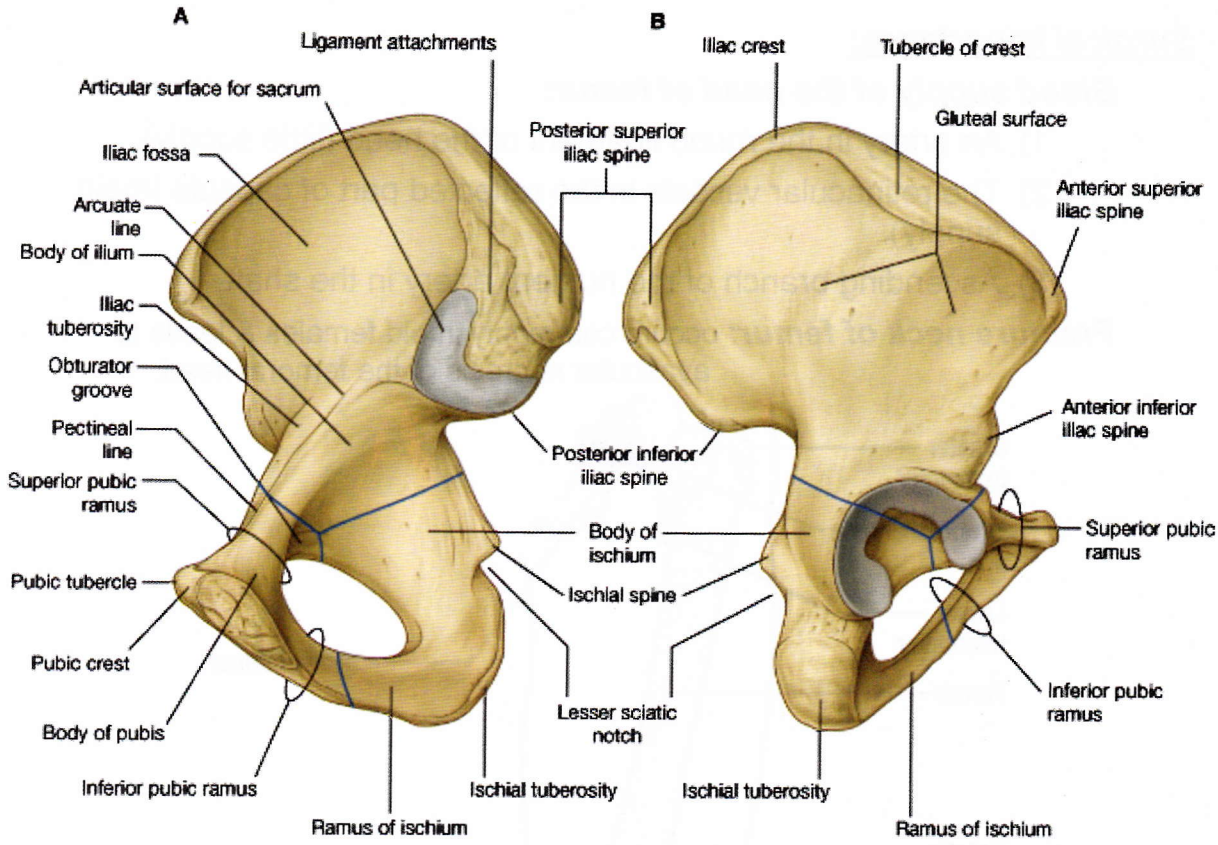
C. **Pubis**: has:

1. Body: its upper border forms the pubic crest which ends laterally by pubic tubercle.
2. Superior ramus: reaches the acetabulum & forms the anterior 1/5.
3. Inferior ramus: joins the ischial ramus.

Surgical importance:

- ***Fracture Hip:***

  Occurs most commonly due to crushing force and leads to fracture of ala of ilium & the conjoined ischio-pubic ramus.



THE FEMUR:

Features:

The femur is the longest and strongest bone in the body.

It consists of upper end, shaft and lower end.

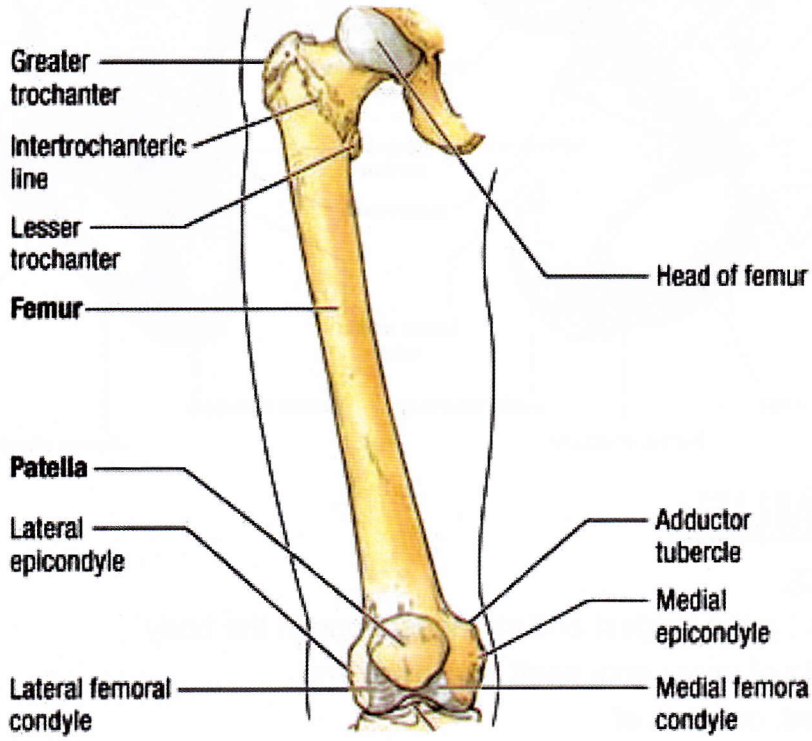
1. **Upper end**: consists of:
   - Head: has a fovea for the round ligament.
   - Neck: forms an angle of 120° with the shaft.
   - Greater trochanter: projects laterally.
   - Lesser trochanter: projects postero-medially.
2. **Shaft**:
   - It has 3 surfaces (anterior, medial & lateral).
   - Its posterior border is thick & shows spiral line called linea aspra.
   - The posterior aspect of upper ¼ shows spiral line (medially) & gluteal tuberosity (laterally).
   - The posterior aspect of lower ¼ shows popliteal surface between medial & lateral supra-condylar ridges.
3. **Lower end:** shows:
   - 2 condyles: medial & lateral.
   - 2 epicondyles.
   - Adductor tubercle: at the lower end of the medial supra-condylar ridge.

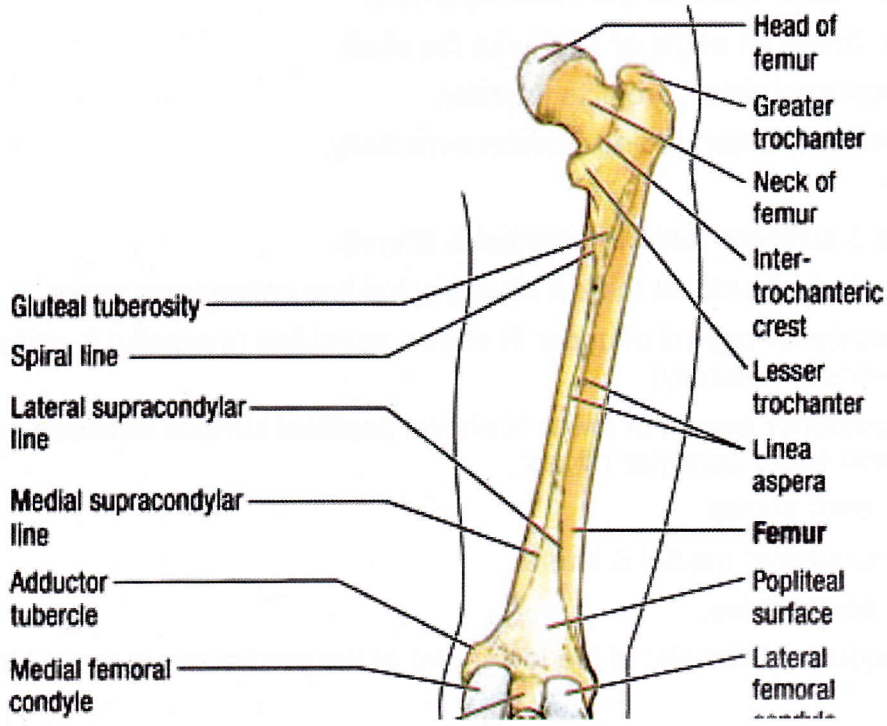
Surgical importance:

Blood supply of the head of femur:

1) An artery in the round ligament of the head (little supply).
2) The retinacular vessels in the reflected part of capsule (main supply).
3) Ascending branch of the nutrient artery in the shaft.

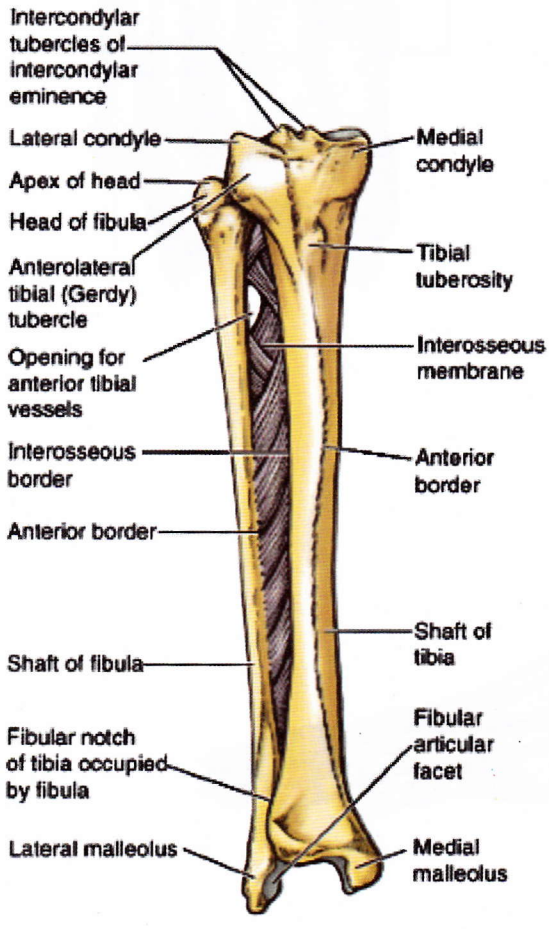
Fracture neck of femur: occurs commonly in old females & leads to avascular necrosis of the femoral head.



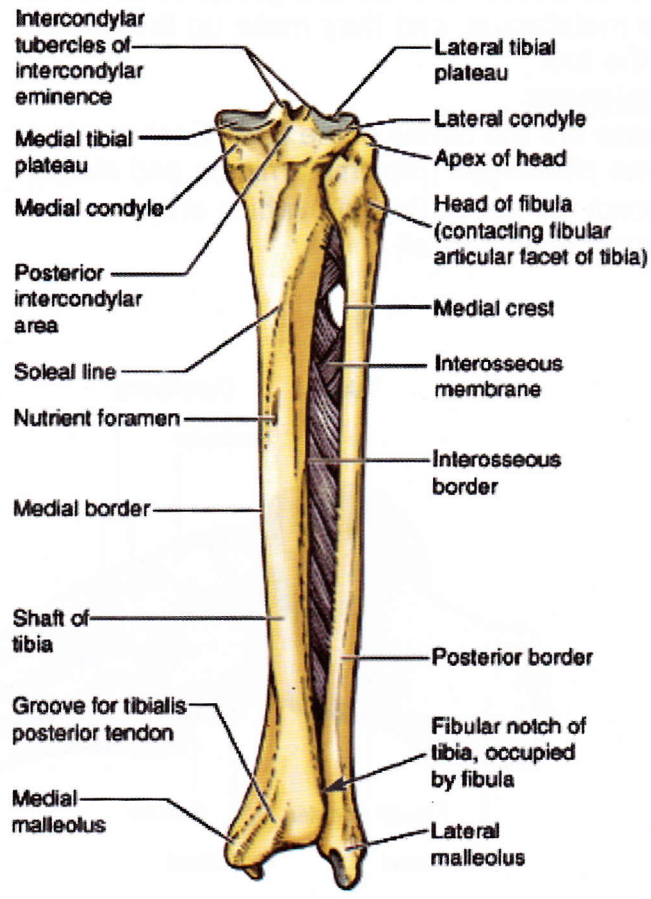


TIBIA & FIBULA:

	TIBIA	FIBULA
Upper end	2 condyles & tibial tuberosity	Head, neck & styloid process,
Shaft	3 borders & 3 surfaces	3 borders & 3 surfaces
Lower end	Large & projects down medially forming the medial malleolus.	Smaller than that of tibia & called lateral malleolus
Surgical importance	Liable to fracture as its medial surface & anterior border are *subcutaneous (has no muscular attachment)* MCQ Upper end of tibia is one of the most common sites of acute osteomyelitis	Ideal bone for grafting as it is not weight bearing Lower end of fibula is fractured spirally in the 1st stage of Pott's fracture



Anterior view (right side)



Posterior view (right side)

The Foot

The foot is made up of **seven tarsal bones**, five metatarsal bones and fourteen phalanges.

Tarsal bones

The collective name for this group of bones is the tarsus. These bones include: calcaneus, talus, navicular, medial cuneiform, intermediate cuneiform, lateral cuneiform and the cuboid.

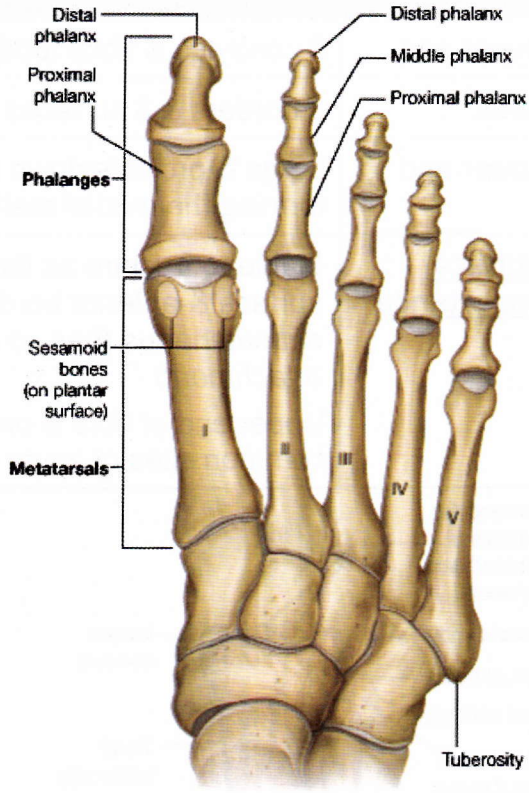
The talus (ankle) articulates with tibia and fibula. Together with the calcaneus (heel bone), they carry most of the body's weight.

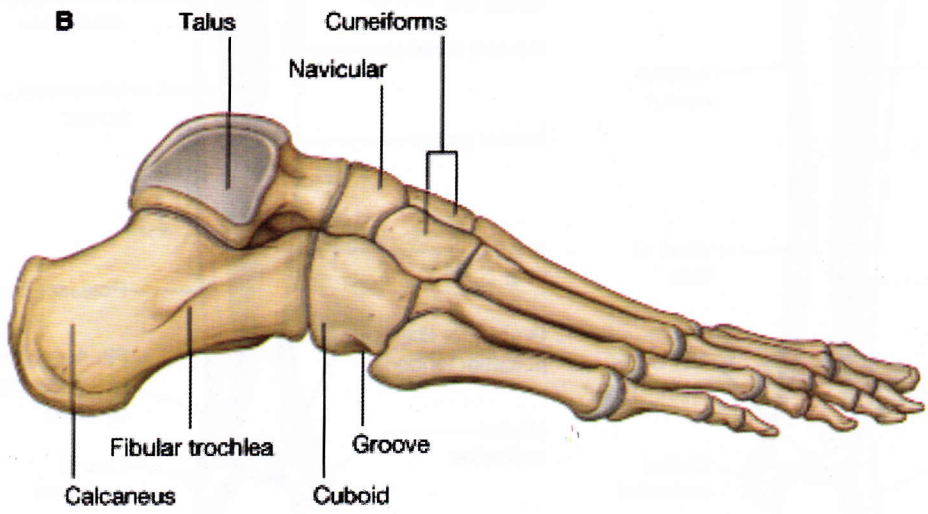
Metatarsal bones

The collective term for this group of bones is the metatarsus, and they make up the middle of the foot.

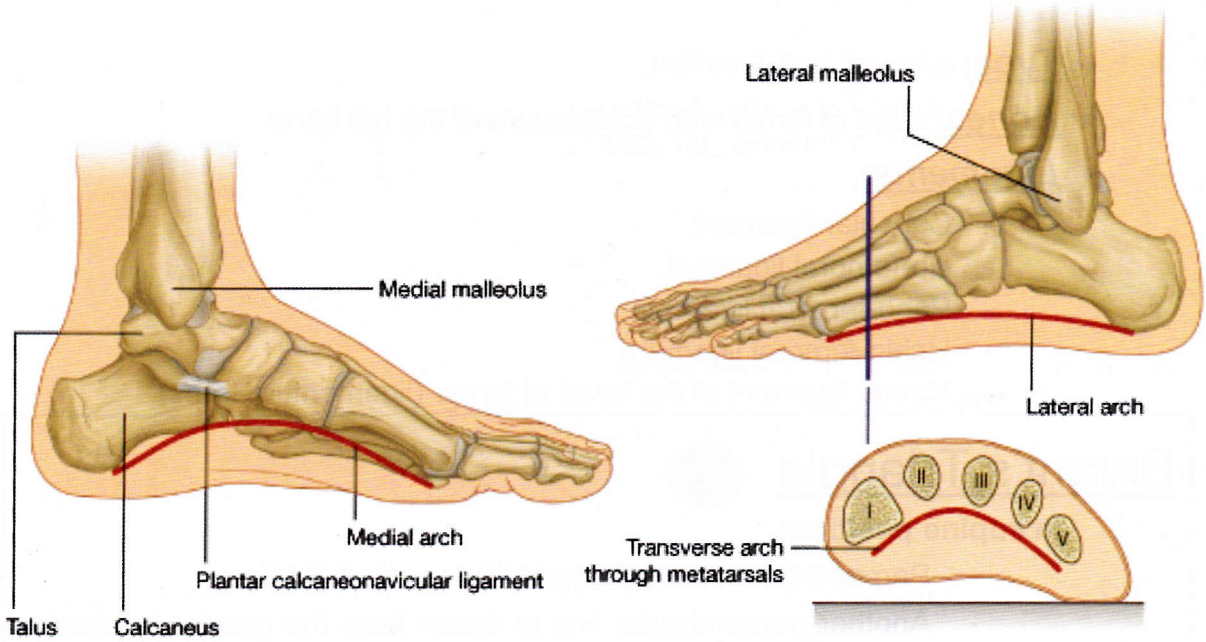
Phalanges

These are the bones of the toes. Each toe has three phalanges (proximal, middle and distal), except the hallux (big toe) which only has two (proximal and distal).





Arches of the foot



The foot has two important functions: weight bearing and propulsion. These functions require a high degree of stability. In addition, the foot must be flexible, so it can adapt to uneven surfaces. The multiple bones and joints of the foot give it flexibility, but these multiple bones must form an arch to support any weight.

The foot has three arches. ***The medial longitudinal arch i***s the highest and most important of the three arches. It is composed of calcaneus, talus, navicular, cuneiforms and first three metatarsals. ***The lateral longitudinal arch*** is lower and flatter than the medial arch. It is composed of calcaneus, cuboid and fourth and fifth metatarsals. ***The transverse arch*** is composed of cuneiforms, cuboid and the five metatarsal bases.

The arches of the foot are maintained not only by the shapes of bones as well as by ligaments; in addition, muscles and tendons play an important role in supporting the arches.

Joints of Lower Limb

HIP JOINT

- ***Type:*** synovial ball & socket.
- ***Bones:*** head of femur with acetabulum of the hip bone.
- ***Ligaments:***
  - Capsular ligament.
  - Ilio-femoral ligament.
  - Pubo-femoral ligament.
  - Ischio-femoral ligament.
  - Round ligament of the head of femur (ligamentum teres).

Bryant's Triangle MCQ

In supine position:

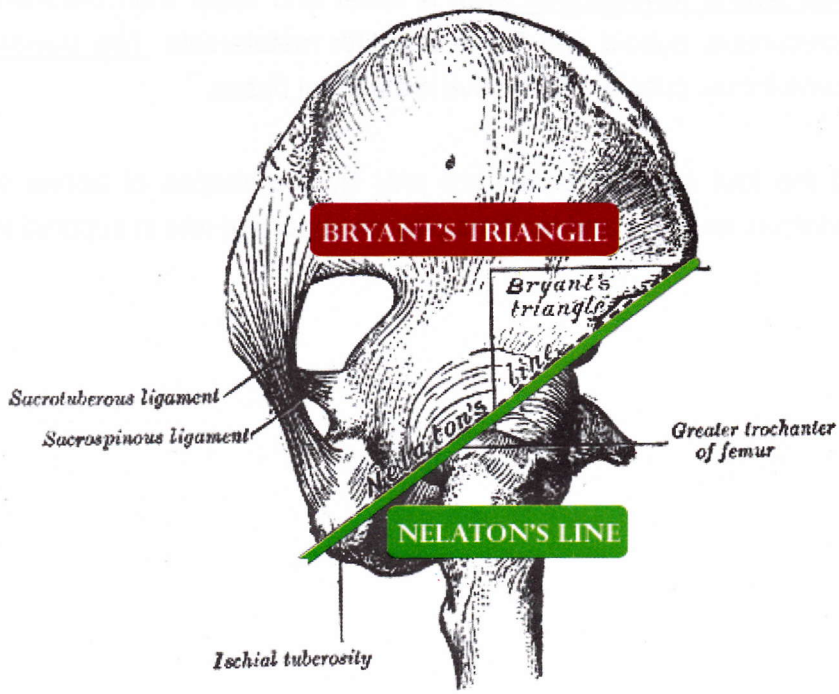
- Perpendicular line is dropped from each A.S.I.S.
- Another perpendicular line is drawn from the greater trochanter to the 1st line.

It is used to assess trochanteric displacement.

N.B: This triangle is not disturbed in fracture shaft of the femur.

Nelaton's line

- It is the line Joining A.S.I.S. & ischial tuberosity.
- Passes by the tip of greater trochanter.
- In supra-trochanteric shortening, greater trochanter lies above the line.



N.B. MCQ

- *The neck of femur is mostly intra-capsular except for its postero-lateral part which is extra-capsular.*
- *In coxa vara: the neck-shaft angle of femur is decreased.*
- ***Trendelenberg test is +ve in:***
  - Paralysis of gluteus medius (not gluteus maximux).
  - Dislocation of the head of femur.
  - Coax vara.

N.B.

1) The greater sciatic foramen transmits the nerves supplying:

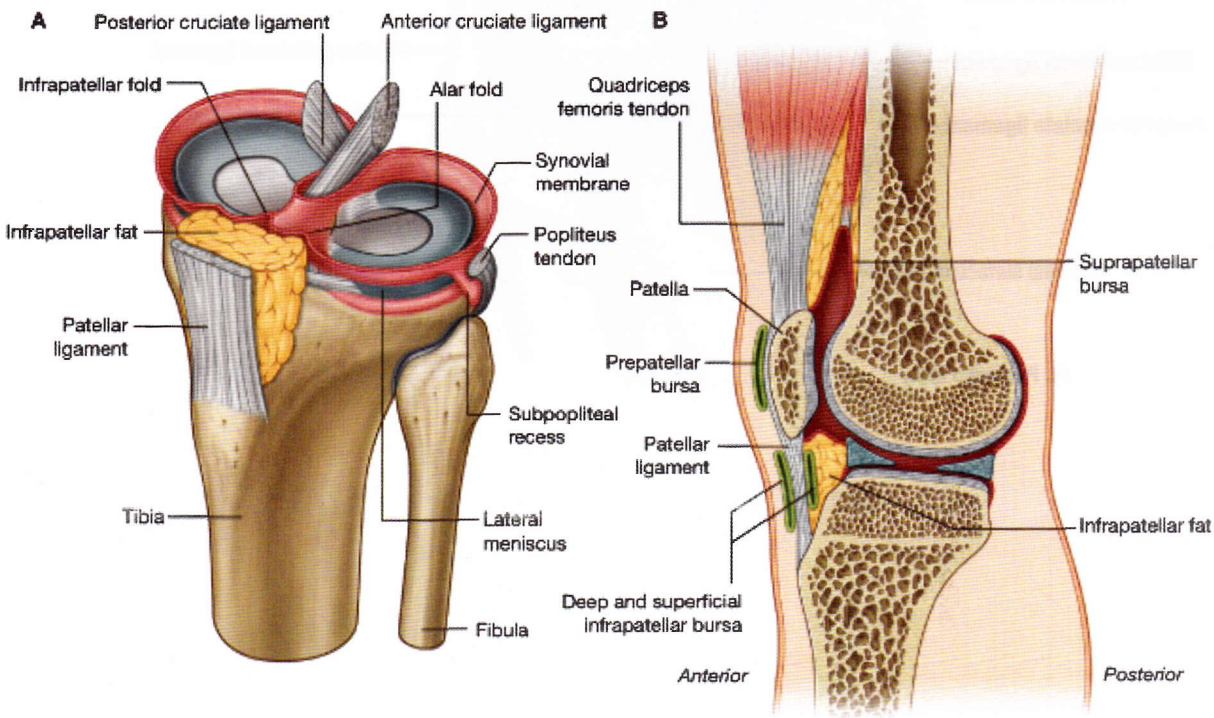
- Tensor fascia lata muscle (superior gluteal nerve).
- Gluteal muscles (superior & inferior gluteal nerves).
- Hamstring muscles (sciatic nerve).
- Perineal muscles (pudendal nerve).

2) Structures passing through lesser sciatic foramen include:

- Tendon of obturator internus & nerve to obturator internus.
- Internal pudendal vessels & pudendal nerve.

KNEE JOINT

- ***Type:*** synovial condylar.
- ***Bones:*** lower end of femur, posterior surface of patella & upper end of tibia.

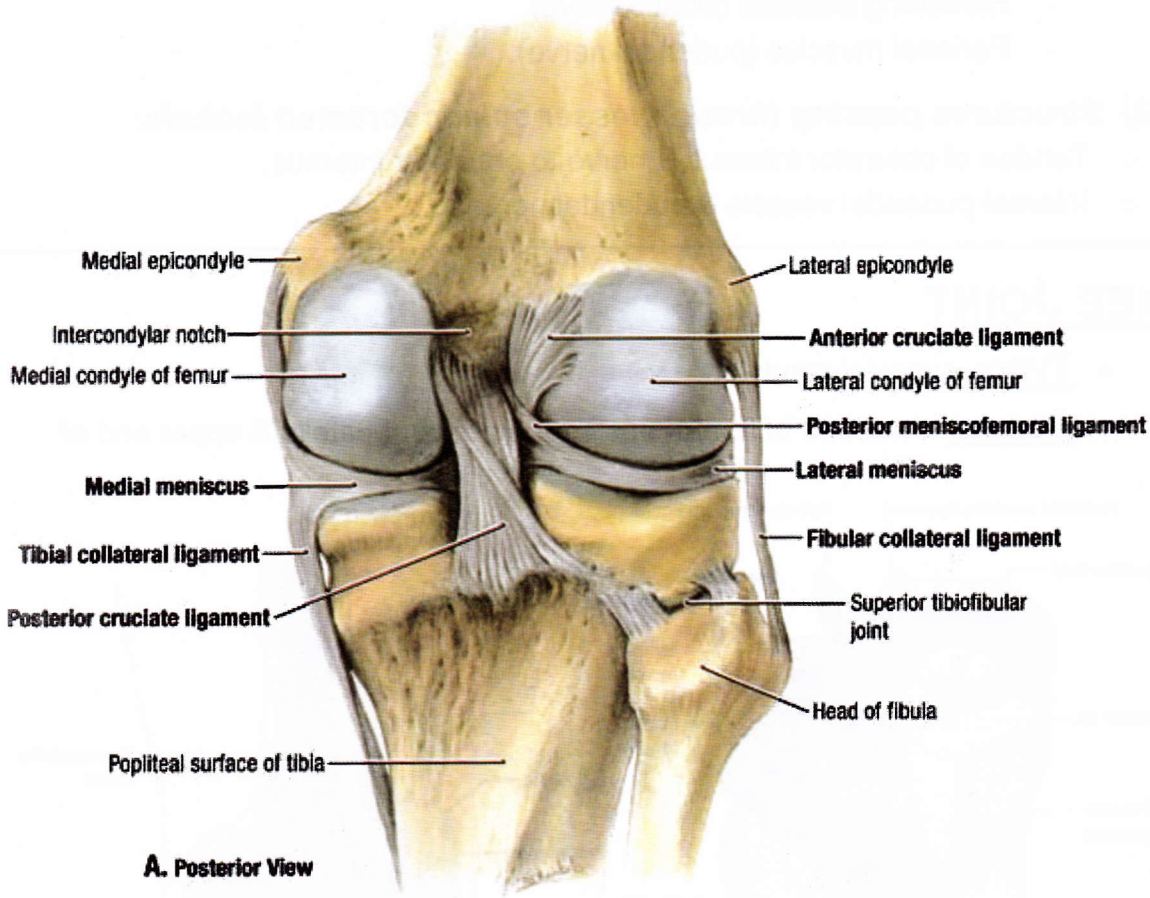


- ***Fibrous Capsule :***

1) Posteriorly & on the sides: the capsule is attached to the articular margins of the tibial & femoral condyles, the inter-condylar line of femur and head of fibula.
2) Anteriorly: the capsule is deficient being continuous with and replaced by three structures. From above downwards, they are :
   - Tendon of quadriceps.
   - Sides of patella.
   - Ligamentum patellae.

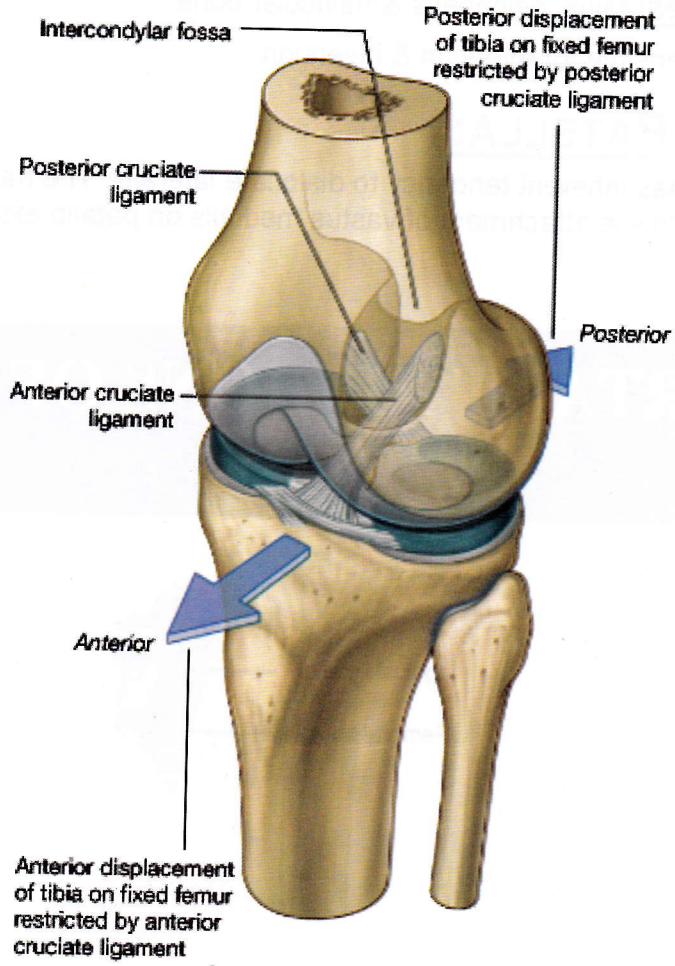
- ***Extra-capsular supporting ligaments:***

Anteriorly	Posteriorly	Medially	Laterally
Ligamentum patellae & patellar retinacula	Oblique popliteal ligament	Tibial collateral ligament	Fibular collateral ligament



- **Intra-capsular structures:**

Paired	4 Single
2 menisci	Transverse ligament
2 cruciate ligaments	Tendon of popliteus
2 menisco-femoral	Infra-patellar pad of fat
	Synovial membrane



MCQ

N.B. Housemaid's knee is the inflammation of pre-patellar bursa.

ANKLE JOINT

- ***Type*:** synovial hinge.
- ***Bones*:** lower ends of tibia, fibula & talus.
- ***Ligaments*:** medial ligament (deltoid ligament) & lateral ligament.

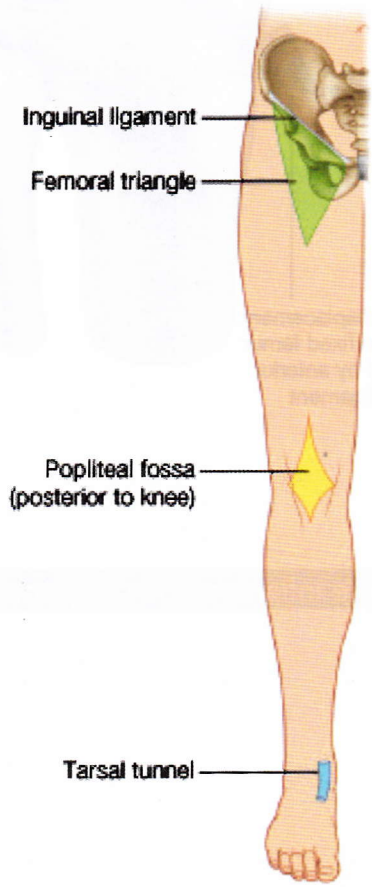
TALO-CALCANEO-NAVICULAR JOINT

- ***Type*:** synovial ball & socket.
- ***Bones*:** talus, calcaneus & navicular bone.
- Responsible for eversion & inversion.

NB: THE PATELLA:

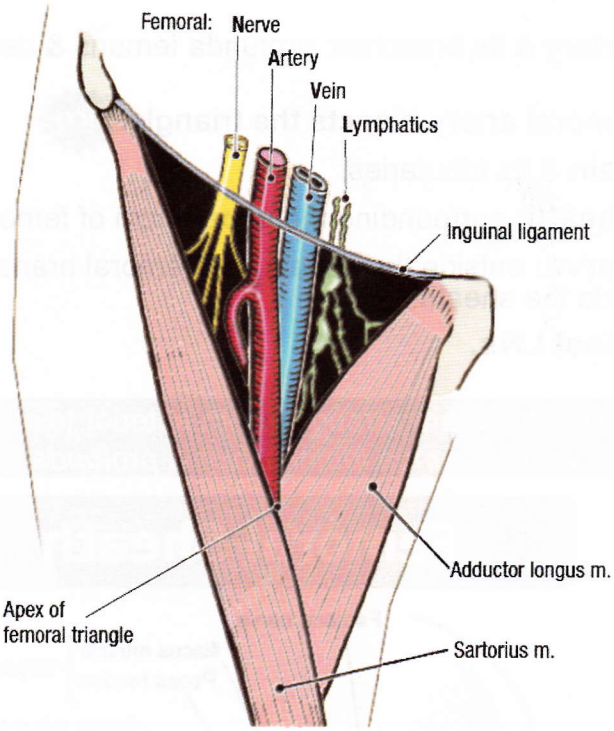
- Patella has inherent tendency to dislocate laterally. The natural mechanism to prevent this is attachment of vastus medialis on patella extension more distally.

IMPORTANT REGIONS OF LOWER LIMB



Femoral Triangle

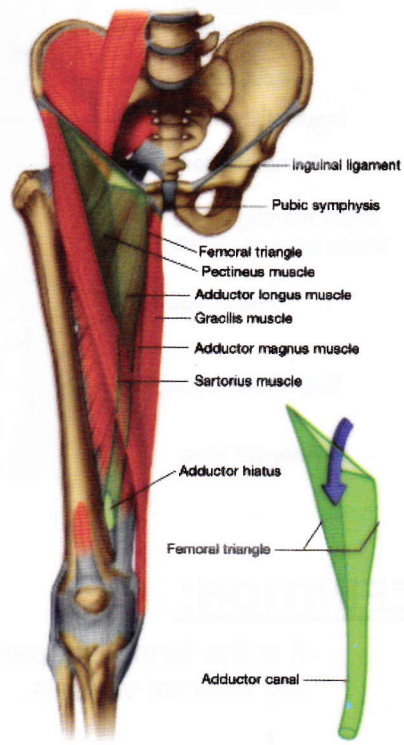
It is a *sub-fascial space* occupying the front of the *upper 1/3* of the thigh just below the inguinal ligament. MCQ



BOUNDARIES:

MCQ

- ***Laterally:*** medial border of sartorius.
- ***Medially:*** **medial** border of adductor longus (so the muscle also shares in the floor).
- ***Base:*** inguinal ligament (Poupart's ligament).
- ***Apex:*** meeting of sartorius & adductor longus (beginning of Hunter's canal).



FLOOR:

MCQ

From medial to lateral: adductor longus, pectineus, psoas major & iliacus muscle.

ROOF:

1. Skin.
2. Superficial fascia consisting of fatty layer & membranous layer just a fingerbreadth below inguinal ligament.

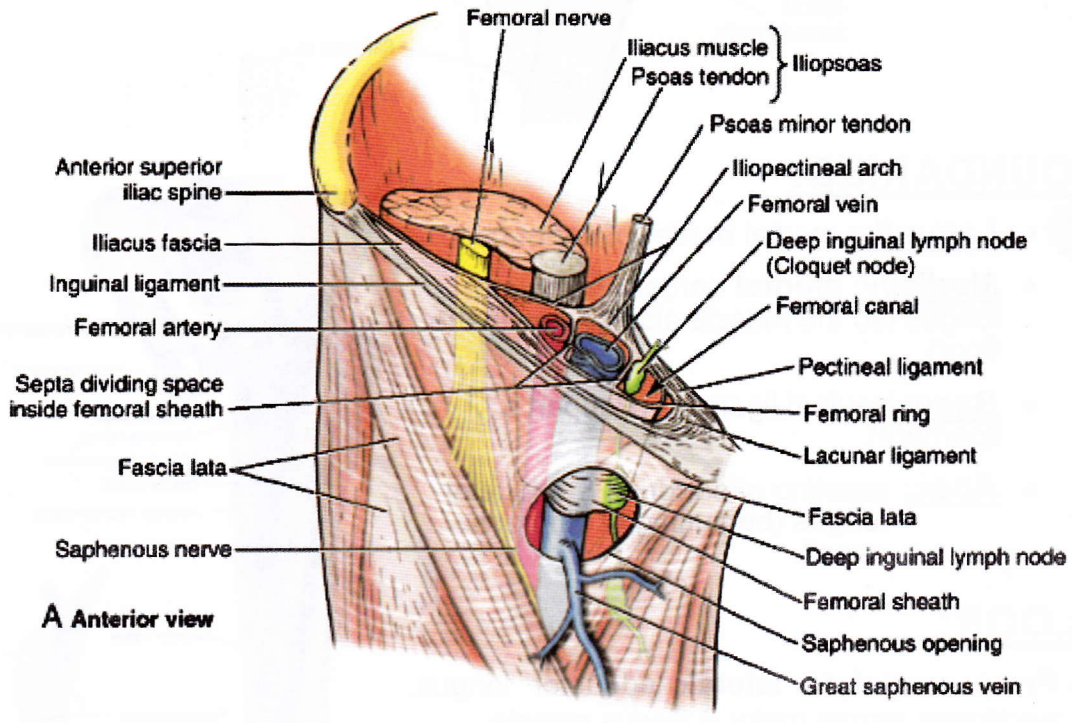
3. In between there are:
    - Superficial branches of femoral artery: superficial epigastric, superficial external pudendal & superficial circumflex iliac.
    - The "T" shaped superficial inguinal lymph nodes.
    - Great saphenous vein & the ilio-inguinal nerve.
4. Deep fascia containing the **saphenous opening** (which is a defect in the fascia covered by cribriform fascia). MCQ

CONTENTS:

1) **Femoral artery** & its branches: profunda femoris & deep external pudendal.
   N.B: **The femoral artery bisects the triangle.** MCQ
2) **Femoral vein** & its tributaries.
3) **Femoral sheath:** surrounding the upper 4 cm of femoral vessels.
4) **Femoral nerve:** outside the sheath, but femoral branch of genito-femoral nerve is inside the sheath. MCQ
5) **Deep inguinal LNs.**

MCQ ***N.B:*** At the apex: structures are arranged from anterior to posterior as: *femoral artery, femoral vein, profunda femoris vein & profunda femoris artery.*

Femoral Sheath



DEFINITION:

It is the funnel shaped fascial sleeve which encloses the upper 4 cm of the femoral vessels.

FUNCTION OF THE FEMORAL SHEATH:

It allows easy & smooth gliding of the femoral vessels during flexion and extension of the thigh at the hip joint.

BOUNDARIES & EXTENT

- ***Site***: below the middle part of Poupart's triangle.
- ***Shape:*** conical.
- ***Size:*** 4 cm long laterally & 1 cm medially.
- ***Anterior Wall:*** fascia transversalis.
- ***Posterior Wall:*** fascia iliaca.

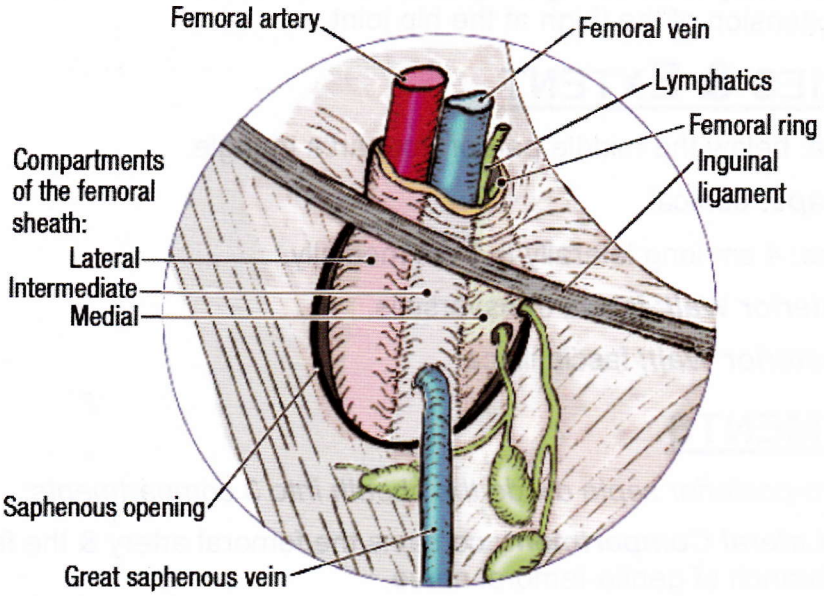
COMPARTMENTS

MCQ

2 antero-posterior septa divide the sheath into 3 compartments:

- ***Lateral Compartment:*** contains the femoral artery & the femoral branch of genito-femoral nerve.
- ***Middle Compartment:*** contains the femoral vein.
- ***Medial Compartment:*** the femoral canal.

Femoral canal



INLET (FEMORAL RING):

- It is the mouth of the femoral canal in the abdomen.
- It is closed by a plug of fat called femoral septum.
- ***Boundaries of femoral ring***
  - **Anterior**: Poupart's ligament (inguinal ligament).
  - **Posterior**: Cooper's ligament (pectineal ligament).
  - **Lateral**: Femoral vein.
  - **Medial**: Sharp crescentic margin of Gimbernat's ligament **(lacunar ligament)**. MCQ

N.B. Inguinal ligament, lacunar ligament & reflected part of inguinal ligament are attached to pubic tubercle

OUTLET (SAPHENOUS OPENING):
Covered by cribriform fascia.

LENGTH:
1.5 cm.

SHAPE:
Funnel shaped.

CONTENTS:
LN of Cloquet, lymphatic vessels & areolar CT fat (fat distribution in femoral canal is higher in the upper part).

POINTS OF SURGICAL IMPORTANCE

a- Femoral ring is wider in females because they have wider pelvis, smaller vessels & weaker ligaments → higher incidence of femoral hernia in females.

b- Femoral hernia descends first downwards in the femoral canal, then forwards through the saphenous opening. Later on, if it becomes larger it curves upwards & laterally in the direction of the A.S.I.S. (this is because of the attachment of Scarpa's fascia to fascia lata at a finger's breadth below the inguinal ligament.

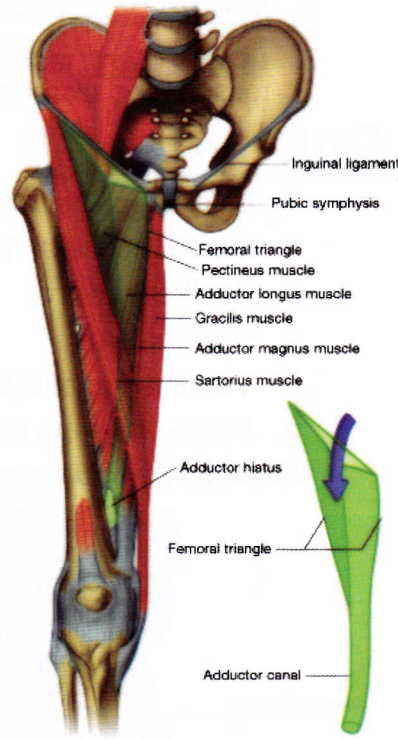
c- Abnormal obturator artery (see vascular anatomy). MCQ

Hunter's Canal (Adductor or Sub-sartorial Canal)

SITE: Middle ⅓ of the thigh. It begins at the apex of femoral triangle & ends at the opening in adductor magnus muscle. MCQ

BOUNDARIES MCQ

- ***Roof:*** a strong fibrous membrane on which lies the sartorius muscle.
- ***Floor:*** adductor longus & magnus muscles
- ***Lateral wall:*** vastus medialis.



CONTENTS

1. **Femoral vessels:** the vein at first is behind the artery then lateral to it.
2. **Descending genicular artery:** from femoral artery (anastomtica magna).
3. **Nerve to vastus medialis**: lateral to the vessels. MCQ
4. **Saphenous nerve:** crosses the vessels from lateral to medial side.

SURGICAL IMPORTANCE:

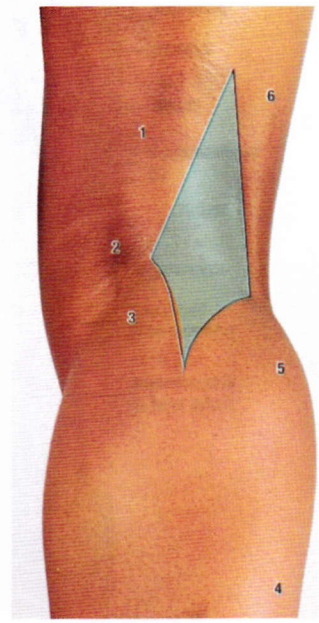
To decrease bleeding in above knee amputation, we ligate the femoral vessels in the canal by dividing the sartorius & its fascia. However, if there is arteriosclerosis, there is no need for ligation.

Popliteal fossa

BOUNDARIES:

MCQ

1. **Upper lateral:** biceps femoris.
2. **Upper medial:** semitendinosus & semimembranosus muscles supplemented by the sartorius, gracilis & adductor magnus.
3. **Lower lateral:** lateral head of gastrocnemius supplemented by the plantaris muscle.
4. **Lower medial:** medial head of gastrocnemius.



ROOF:

The roof of the fossa is formed by:

- Skin.
- Superficial fascia containing:
  - The upper part of short saphenous vein.
  - Branches of posterior cutaneous nerve of thigh.
- Popliteal fascia (deep fascia of the roof which is a downward extension of the fascia lata. *It is pierced by saphenous vein).*

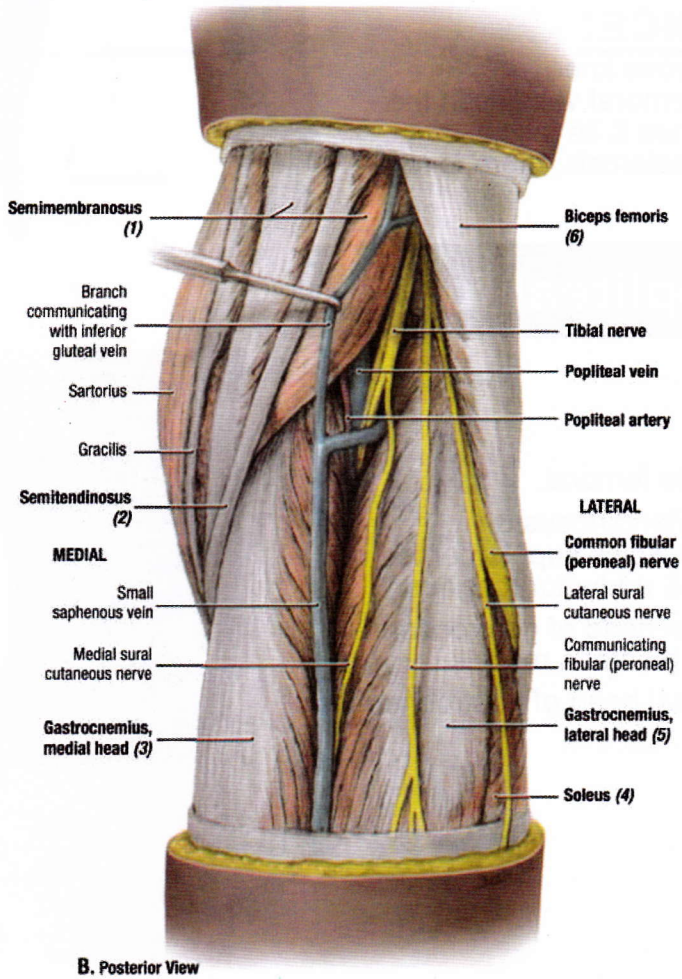
FLOOR: MCQ

1. ***Upper part:*** popliteal surface of femur.
2. ***Middle part:*** back of the capsule of the knee joint.
3. ***Lower part:*** fascia covering the popliteus muscle. The lower limit of the fossa is the distal border of the popliteus muscle.

CONTENTS: MCQ

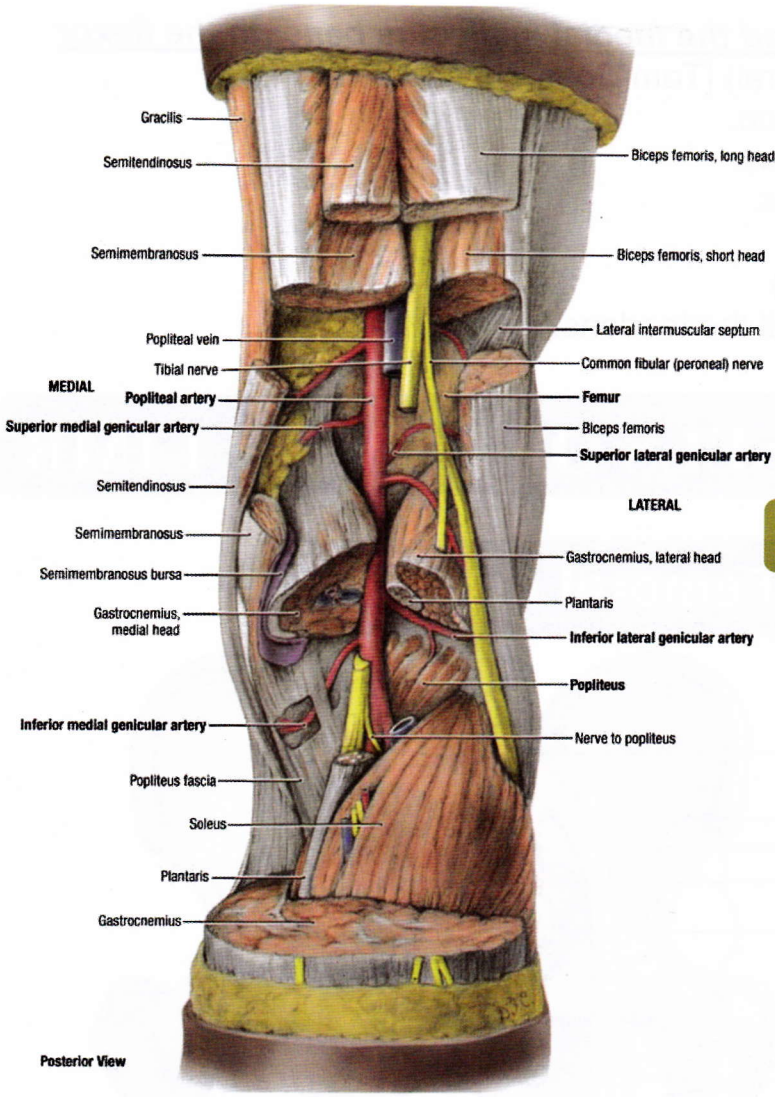
1. Lateral popliteal nerve **(common peroneal nerve)**.
2. Medial popliteal nerve **(tibial nerve)**.
3. Popliteal artery.
4. Popliteal vein.
5. Termination of the **posterior cutaneous nerve of the thigh**.
6. Popliteal lymph nodes.

All these structures are embedded in a variable amount of fat.



B. Posterior View

Superficial Dissection



Deep Dissection

Structures around ankle

RETINACULA.

There are two retinacula: extensor and flexor. These are formed by thickened deep fascia and their function is to maintain the position of long tendons crossing the ankle.

Structures that pass anterior to the extensor retinaculum on the anterior surface of the ankle: (medial to lateral)

- Saphenous nerve and great saphenous vein (anterior to medial malleolus).
- Superficial peroneal nerve.

Structures that pass deep to the extensor retinaculum (medial to lateral) [**T**om **H**as **V**ery **N**ice **D**og & **P**ig]

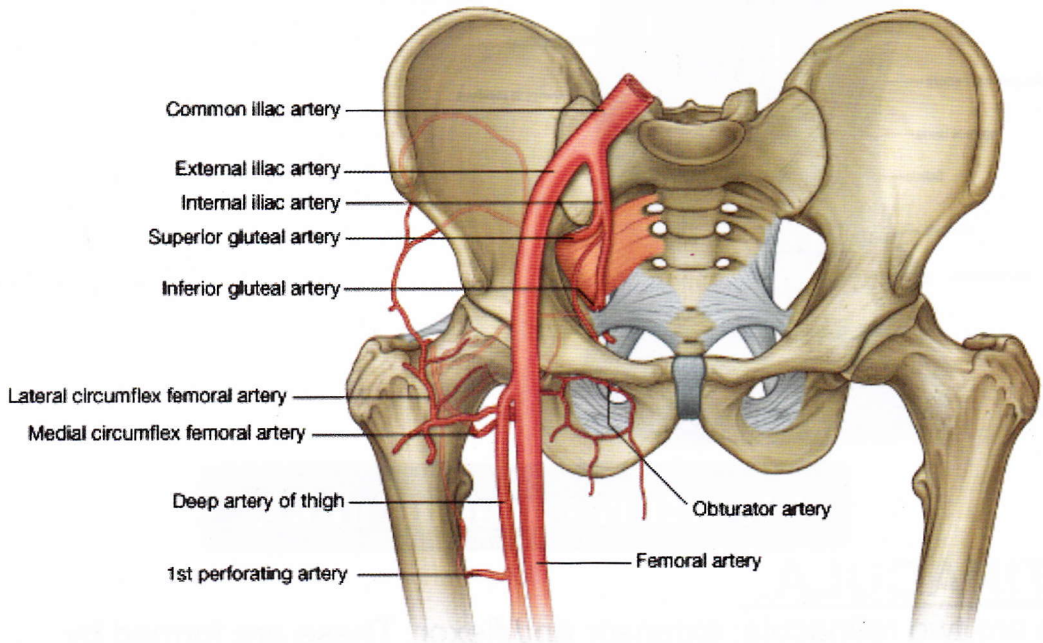
- **T**ibialis anterior tendon.
- Extensor **h**allucis longus tendon.
- Anterior tibial **v**essels.
- Deep peroneal **n**erve.
- Extensor **d**igitorum longus tendon.
- **P**eroneus tertius.

Structures that pass behind the medial malleolus beneath the flexor retinaculum (medial to lateral) [**T**om **D**oes **V**ery **N**ice **H**at]

- **T**ibialis posterior tendon.
- Flexor **d**igitorum longus.
- Posterior tibial **v**essels.
- Tibial **n**erve.
- Flexor **h**allucis longus.
- Synovial sheaths of all the tendons.

BLOOD VESSELS OF LOWER LIMB

Femoral Artery



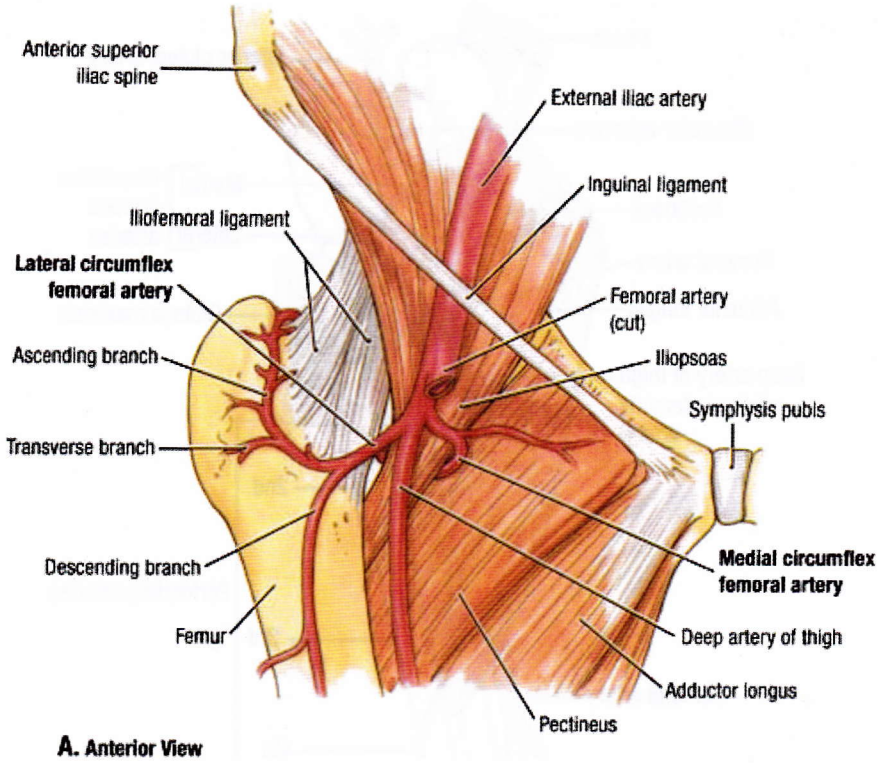
BEGINS: As the continuation of external iliac artery behind the mid-inguinal point (midway between A.S.I.S. & symphysis pubis). MCQ

ENDS: By becoming the popliteal artery by passing through an opening in the adductor magnus between its 2 insertions (10 cm above knee joint). MCQ

SURFACE ANATOMY:

With the thigh flexed, abducted & laterally rotated:

It corresponds to the upper ⅔ of a line drawn from the mid-inguinal point to the adductor tubercle.



A. Anterior View

BRANCHES:

It is the main artery of the LL & also supplies part of the anterior abdominal wall.

MCQ

A) 3 Superficial

MCQ

- Superficial external pudendal artery.
- Superficial epigastric artery.
- Superficial circumflex iliac artery.

B) 3 Deep

- *Deep external pudendal artery.*
- ***Deep femoral artery (profunda femoris artery):***

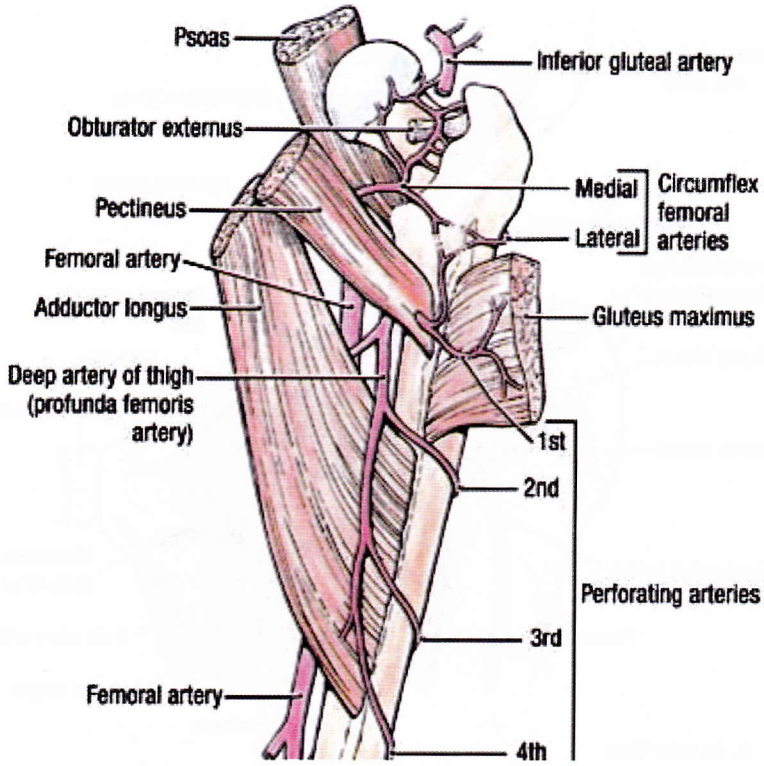
MCQ

  - It arises from the postero-lateral aspect of the common femoral artery 2-4 cm distal to the inguinal ligament.
  - It is the main supply to medial & posterior compartments of the thigh.
  - It gives 6 branches:
    - Lateral femoral circumflex artery.
    - Medial femoral circumflex artery.
    - 4 perforating branches piercing the adductor magnus M.

- ***Descending genicular artery (anastomtica magna):***

MCQ

  - Enters into the collateral circulation around the knee.



RELATIONS:

- ***Common Femoral artery:*** ***(above origin of profunda femoris artery)***

  Lies in the lateral compartment of the femoral sheath, so:

  - ***Medially*** is the femoral vein.
  - ***Laterally*** is the femoral branch of the genito-femoral nerve and femoral nerve.
  - ***Posteriorly*** it lies on psoas major and pectineus muscle.

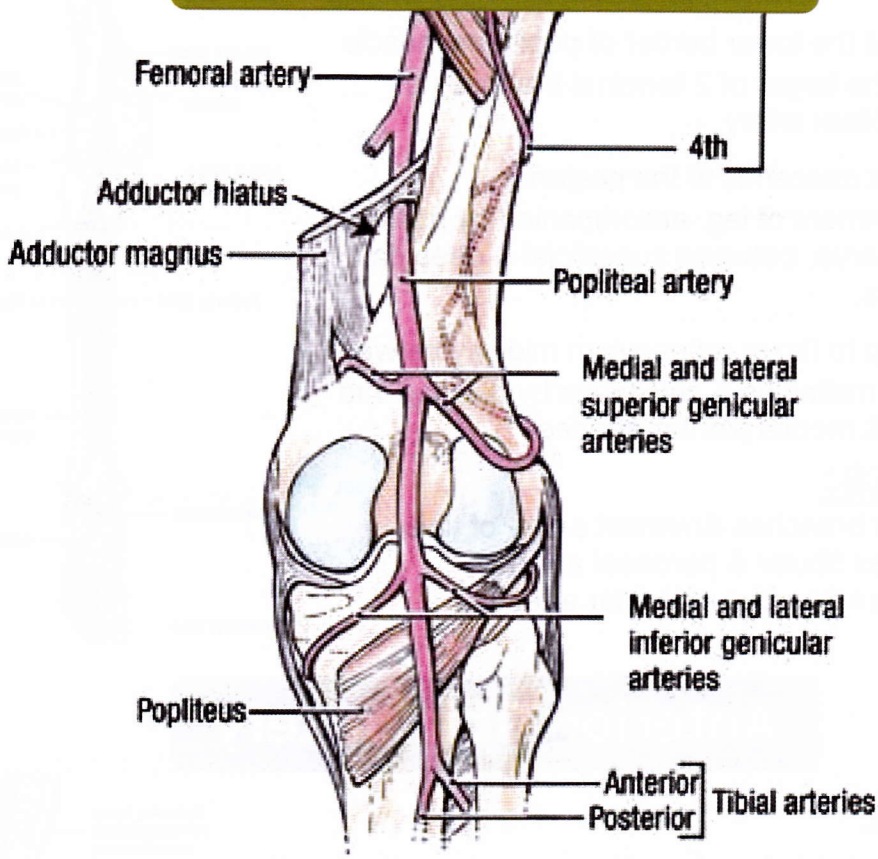
- ***Superficial Femoral artery:*** ***(below origin of profunda femoris artery)***

  - Passes first in the femoral triangle.
    - Deep to it are the profunda vessels, pectineus & adductor longus muscles.
    - The femoral vein is first medial then behind the artery.
  - Then the artery passes in Hunter's canal.
    - It lies posterior to sartorius.
    - The femoral vein is first behind then lateral to the artery.

EXPOSURE

- The femoral vessels are best exposed by a vertical incision 15 cm long and centered over the mid-femoral point.
- The deep fascia of the leg is incised and the artery is found lying lateral to the common femoral vein.
- The contents of the inguinal canal are protected by upward retraction.

Popliteal Artery



BEGINS: As a continuation of femoral artery at the **adductor hiatus**.

COURSE: It descends as the deepest structure in the popliteal fossa over the floor of popliteal fossa. MCQ

ENDS:

At the lower border of popliteus muscle by dividing into 2 terminal branches: anterior & posterior tibial arteries.

MCQ **BRANCHES:**

- Muscular branches *(it supplies the extensor compartment of the leg).*
- 5 genicular branches.

SURGICAL IMPORTANCE:

a) Popliteal artery is the commonest site of peripheral arterial aneurysm due to:

- Constant pulsation of the artery against the underlying adductor magnus may cause changes in the arterial wall.
- Popliteal artery is fixed to the capsule of the knee joint by fibrous band just above the femoral condyles. This may be a source of continuous traction on the artery.

MCQ

b) Popliteal pulse is palpated easily when leg is *semi-flexed.*

Posterior Tibial Artery

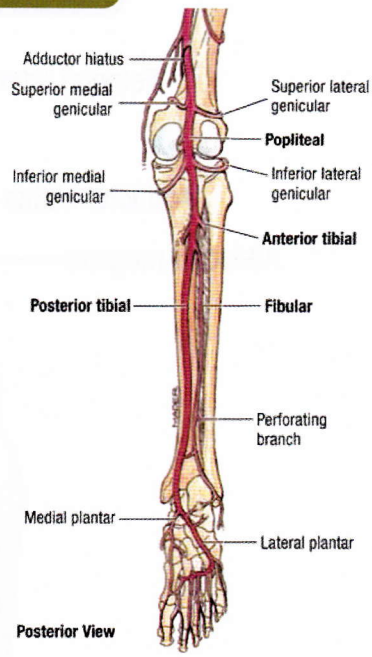
BEGINS: At the lower border of popliteus muscle as the larger of 2 terminal branches of popliteal artery.

COURSE: It descends in the posterior compartment of leg, accompanied by posterior Tibial nerve, between superficial & deep calf muscles.

ENDS: Deep to flexor retinaculum midway between medial malleolus & calcaneus by dividing into lateral & medial plantar arteries.

BRANCHES:

1. Muscular branches &nutrient artery of tibia.
2. Circumflex fibular & peroneal arteries.
3. Calcanean &medial malleolar arteries.



Anterior Tibial Artery

BEGINS:

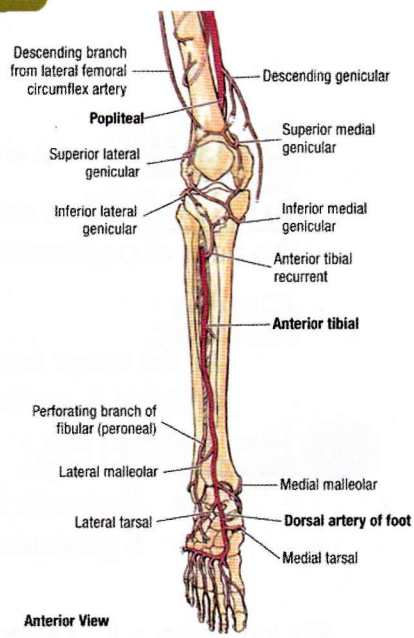
At the lower border of popliteus muscle as the smaller of the 2 terminal branches of popliteal artery.

ENDS:

In front of the ankle joint midway between the 2 malleoli by becoming the dorsalis pedis artery.

BRANCHES:

1. Posterior and anterior tibial recurrent arteries.
2. Muscular branches.
3. Anterior medial malleolar artery.
4. Anterior lateral malleolar artery.
5. Circumflex fibular artery.



MCQ

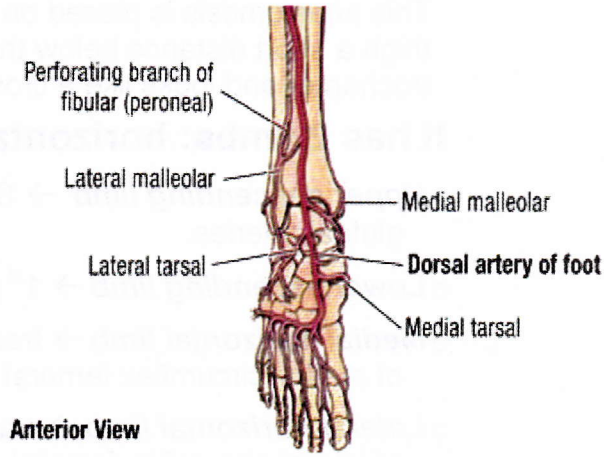
Dorsalis Pedis Artery

BEGINS: As a direct continuation of ***anterior tibial*** artery in front of ankle joint.

ENDS: In the sole by completing the plantar arterial arch

BRANCHES:

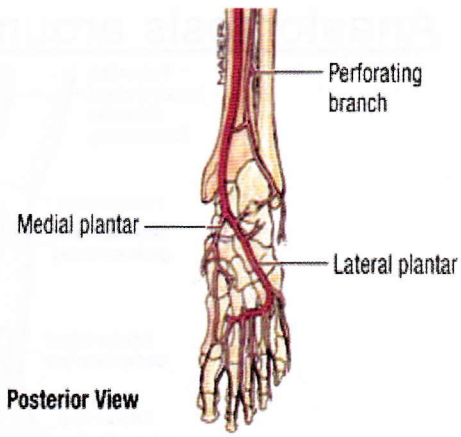
- Medial & lateral tarsal arteries.
- 1st dorsal metatarsal artery.
- Arcuate artery (gives the 2nd, 3rd & 4th metatarsal arteries).



Dorsalis pedis pulsation can be felt on the dorsum of foot lateral to the tendon of extensor hallucis longus against navicular bone.

Arteries of the sole

The arteries of the sole of the foot are derived from the posterior tibial artery. It splits into **medial and lateral plantar arteries**.
Medial plantar artery passes along the medial part of the sole of the foot and terminates by branching into digital branches.
Lateral plantar artery becomes the plantar arterial arch which anastomoses by way of a perforating artery with dorsalis pedis artery. The arch gives rise to several metatarsal branches which split into digital branches.



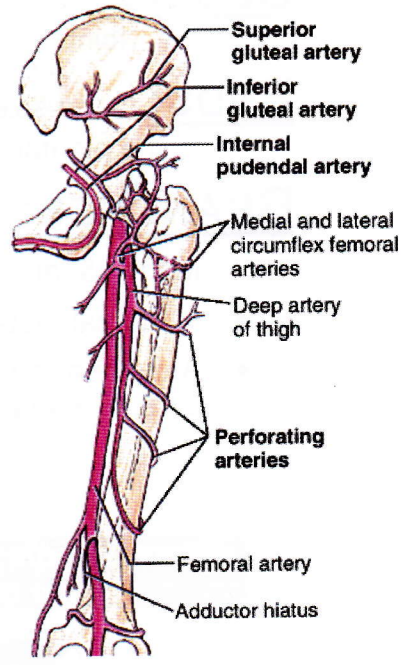
IMPORTANT ARTERIAL ANASTOMOSIS IN THE LOWER LIMB

A- Cruciate Anastmosis of the Thigh

This anastomosis is placed on the back of the thigh a short distance below the greater trochanter and looks like a cross.

It has 2 limbs: horizontal & vertical

- ***Upper descending limb*** → Superior & inferior gluteal arteries.
- ***Lower ascending limb*** → 1st perforating artery.
- ***Medial horizontal limb*** → transverse branches of medial circumflex femoral artery.
- ***Lateral horizontal limb*** → transverse branches of lateral circumflex femoral artery.

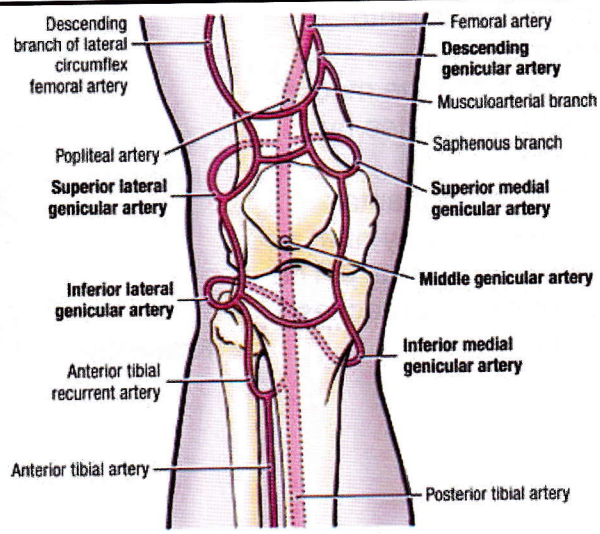


Posterior view

Advantages of Cruciate anastomosis:

It connects internal iliac artery with femoral artery. So, if external iliac is obstructed, the internal iliac artery can supply the thigh.

B- Anastomosis around the Knee Joint



A. Anterior View

- Descending genicular branch of femoral artery.
- Descending branch of the lateral circumflex femoral artery.
- 5 genicular branches from popliteal artery.
- Anterior and posterior tibial recurrent branches from the anterior tibial artery.
- Circumflex fibular branch of the posterior tibial artery.

VENOUS SYSTEM OF LOWER LIMB

The venous system of the lower limb is formed of superficial & deep systems according to the relation to the deep fascia & **perforators to communicate both**.

The Deep System

It starts by:

1- Venae comittant with the anterior & posterior tibial arteries.

2- Peroneal veins.

3- Soleal venous plexus.
→ which together form the popliteal vein → then the femoral vein.

MCQ ***The femoral vein:***

- Accompanies femoral artery through opening in adductor magnus.
- In the adductor canal: saphenous nerve passes from lateral to medial superficial to it.
- Passes anterior to the upper attachment of the pectineus muscle.

The Superficial System

Long Saphenous	Short Saphenous MCQ
- From medial part of the venous arch.	- From lateral part of the venous arch.
- In front of the medial malleolus.	- Behind the lateral malleolus.
- In the medial side of the leg.	- In the lateral side of the leg.
- Postero-medial to the medial condyle.	- Posterior to the popliteal fossa.
- Joins the femoral vein at the saphenous opening 4 cm below & lateral to the pubic tubercle.	- Joins the popliteal vein in the middle of popliteal fossa (sapheno-popliteal junction is variable, as short saphenous may open in the femoral or long saphenous vein).
- It accompanies the saphenous nerve in the leg (might be injured during stripping operation → anesthesia or hyperesthesia in medial side of the leg).	- It accompanies the sural nerve.

3 superficial veins drain into the long saphenous:

- Superficial circumflex iliac.
- Superficial epigastric.
- Superficial external pudendal.

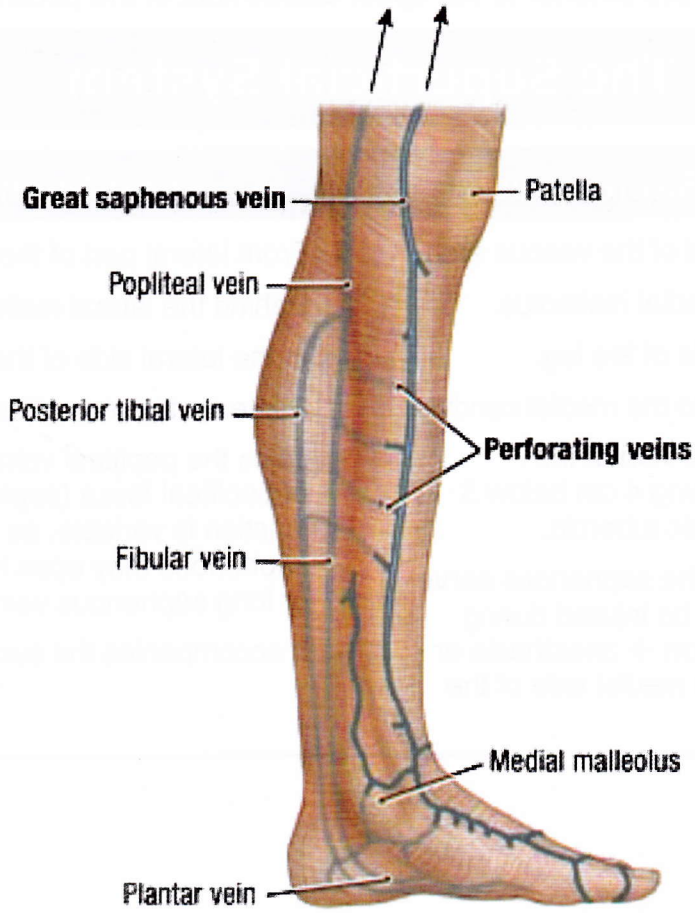
Other tributaries:

- Antero-lateral: from the thigh.
- Postero-medial: from the thigh.
- Vein of Leonardo da Vinci: from the calf.

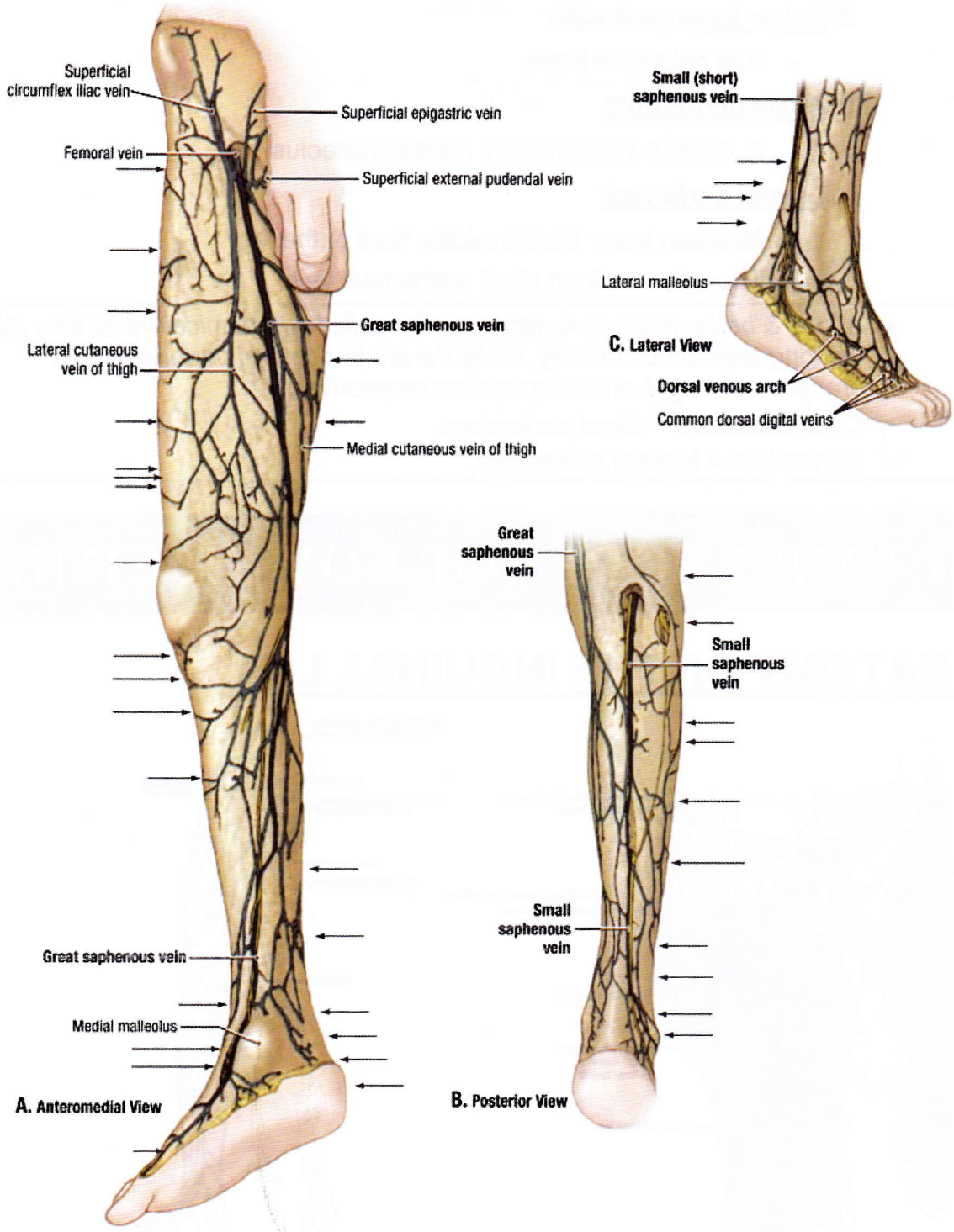
N.B:

- Long saphenous is the longest vein in the body.
- The commonest site for vene-section of long saphenous vein is anterior to the medial malleolus.

Long saphenous contains valves → unidirectional blood flow.



A. Medial View



THE PERFORATORS

MCQ

- They are provided by valves to allow the passage of the blood from the superficial system to the deep system.
- They are variable in number & site.
- The most fixed distribution:

1. Above knee perforator

- Between the lower third & middle third of the thigh.
- It is called Hunter perforator as it is presents near to Hunter canal.

2. Below knee perforator

- Just below the knee.

3. Ankle perforators

- 2, 4 and 6 inches above medial malleolus.

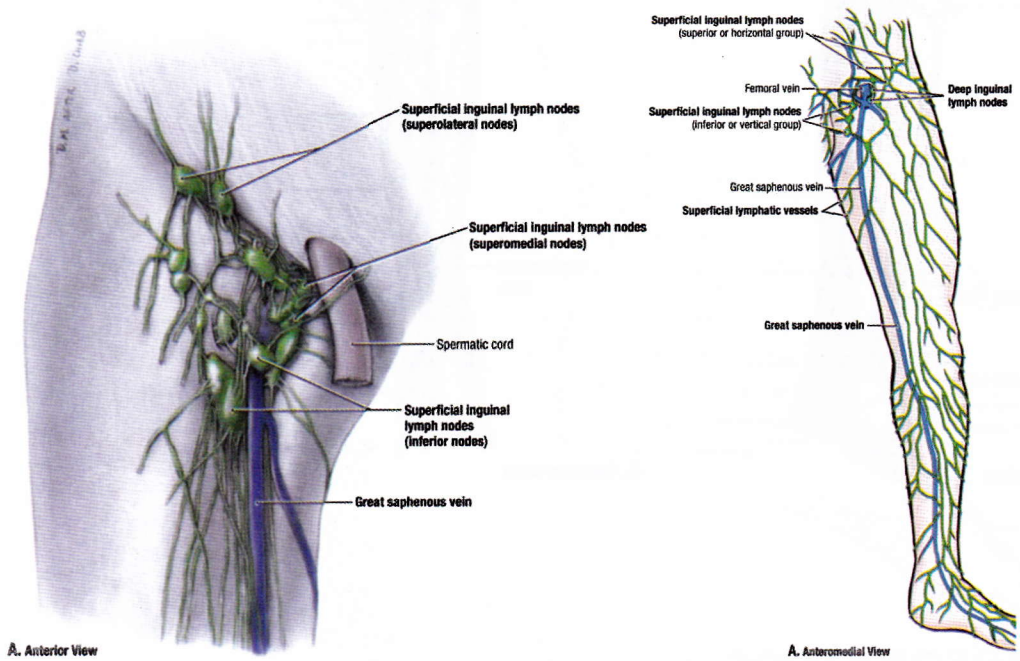
4. Lateral perforator

- Between lower third & middle third of the leg.
- The only one from short saphenous vein.

- *Above & below knee perforators can be called communicators as they join the long saphenous directly, while the ankle & lateral perforators join branches of long & short saphenous respectively.*
- *Communicators = direct perforators.*
- *Perforators = indirect perforators.*

LYMPH NODES OF LOWER LIMB

ANATOMY OF THE INGUINAL LNs:



They are present below the inguinal ligament and they consist of two groups:

A-Superficial Inguinal Glands (superficial to fascia lata)

1) Horizontal (transverse) group:

- **Site**: 1 cm below & parallel to inguinal ligament. MCQ

- ***It receives lymph from***
    - Skin from the umbilicus & the lower back.
    - Perineum.
    - Anal canal (lower part).
    - Gluteal region.
    - Genitalia:
        - In ♂: penis, scrotum and mucous membrane of anterior urethra.
        - In ♀: lower part of the vagina and vulva.

MCQ - ***Efferent***: Up to axilla & down to the groin.

2) Vertical group:

- Runs along the saphenous vein.
- Receives lymph from the entire lower limb.
- The only glands in the body which may be normally palpable.

B-Deep inguinal lymph glands (Cloquet)

- Deep to the fascia lata & on the inner aspect of the femoral vein *(inside the femoral canal)*.
- 2 - 3 in number.
- *It receives lymph from*
    1. Superficial LNs.
    2. Lymph vessels running with the femoral vein.
- It drains to the external iliac LNs.

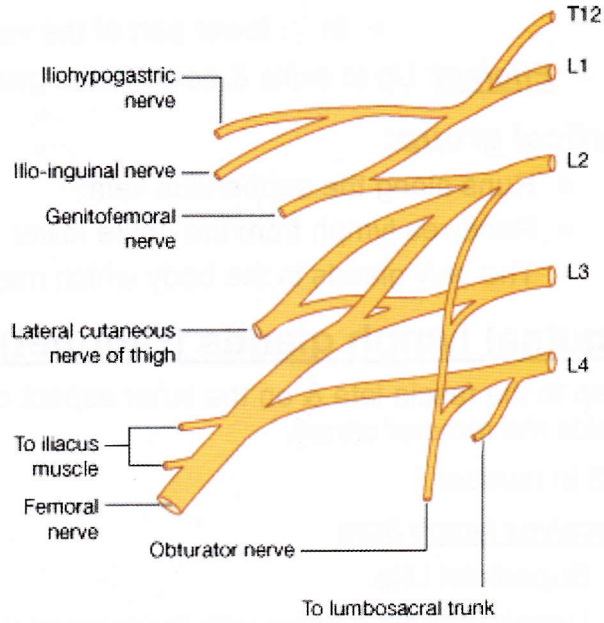
In the lymph drainage of the lower limb:

- The deep vessels pass with the limb arteries.
- The popliteal nodes receive afferents from the area drained by the small saphenous vein.

NERVES OF LOWER LIMB

Femoral Nerve

The femoral nerve is the largest branch of the lumbar plexus. It is formed from the posterior divisions of L2, L3 & L4 roots of lumbar plexus.



COURSE:

It descends through the fibers of the psoas major, emerging from the muscle at the lower part of its lateral border, and passes down between it and the iliacus and behind the iliac fascia.

It then runs beneath the inguinal ligament, into the thigh, and splits into an anterior division and a posterior division.

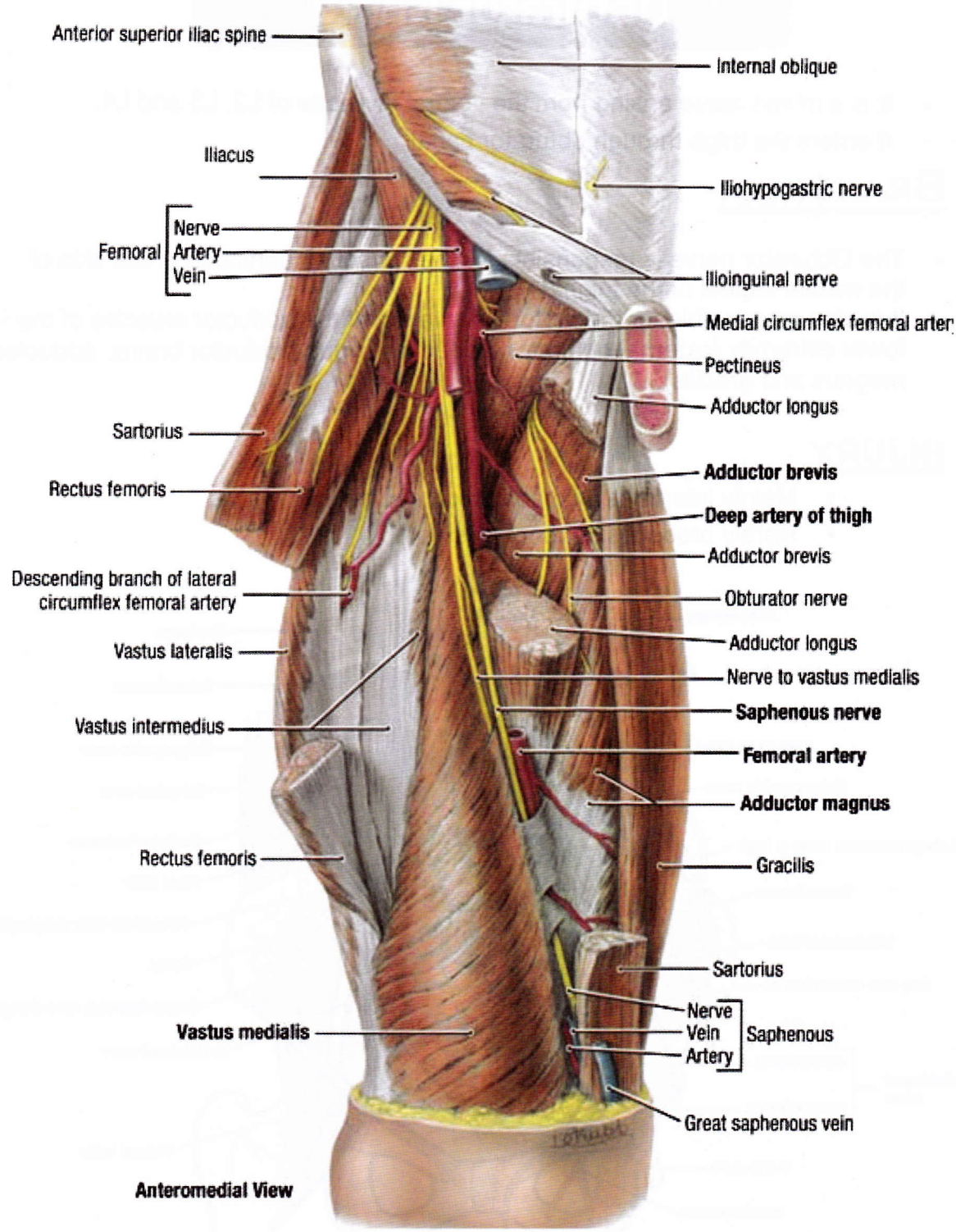
Under the inguinal ligament, it is separated from the femoral artery by a portion of the psoas major.

BRANCHES:

4 to muscles: iliacus, sartorius, pectinus and quadriceps.
3 cutaneous: intermdiate cutaneous nerve of thigh, medial cutaneous nerve of thigh and saphenous nerve.
2 articular: branch to hip joint and branch to knee joint.

INJURY

- Inability to extend the knee (quadriceps femoris).
- Sensory loss over the medial and intermediate aspects of thigh & the medial side leg.



THE SAPHENOUS NERVE

- It is a branch of the femoral nerve in the adductor canal.
- It leaves adductor canal under sartorius → to medial side of the knee → accompanies great saphenous vein.
- It supplies sensation to the medial side of leg and foot up to ball of big toe.
- It is the longest nerve in the body & can be used as nerve graft.

Obturator Nerve

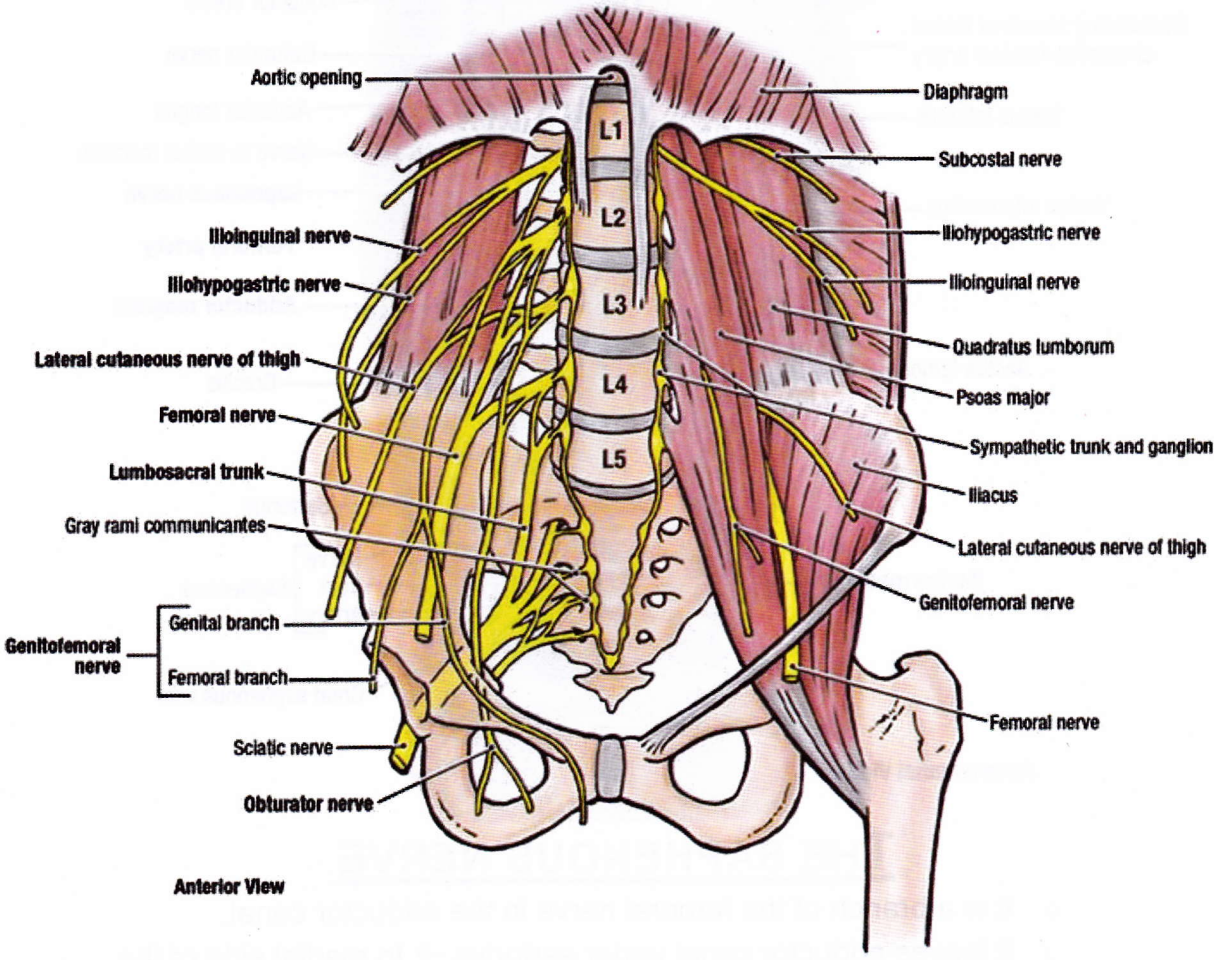
- It is a mixed nerve arising from the ventral divisions of L2, L3 and L4.
- It enters the thigh through obturator canal.

BRANCHES:

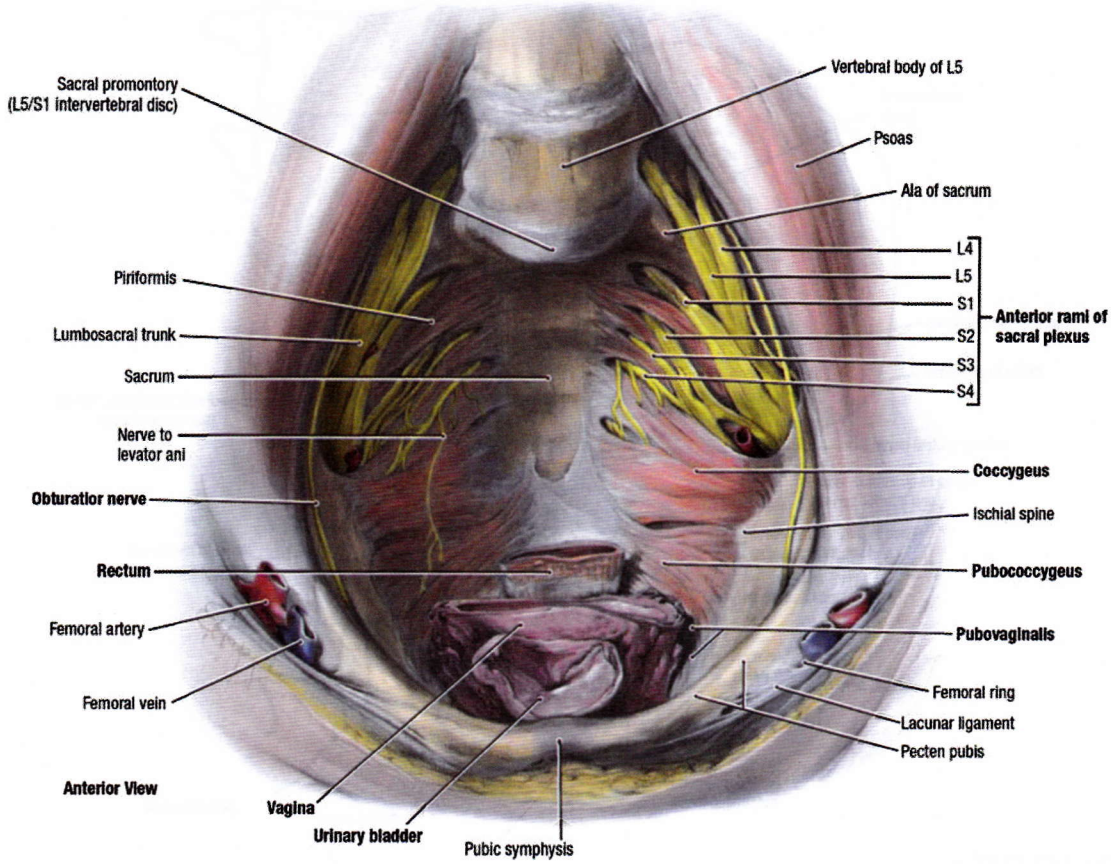
- The Obturator nerve is responsible for the sensory innervation of the skin of the medial aspect of the thigh.
- It is also responsible for the motor innervation of the adductor muscles of the lower extremity (external obturator, adductor longus, adductor brevis, adductor magnus and gracilis).

INJURY

- Mainly interferes with adduction of hip joint.
- Rarely produces sensory loss.



Sacral Plexus



- Lies on the posterior wall of the pelvis in front of piriformis muscle.
- Formed by lumbo-sacral trunk (L4 & L5) and ventral rami of S1, S2, S3 & part of the ventral ramus of S4.

Branches From The Ventral Divisions

- → Nerve to quadratus femoris & gemellus inferior (L4, L5 & S1).
- → Nerve to obturator internus & gemellus superior (L5, S1 & S2).
- → Pudendal nerve (S2, S3 & S4).
- → Muscular branches to levator ani, coccygeus & sphincter ani externus (S4).
- → Pelvic splanchnic nerve (S2, S3 & S4).

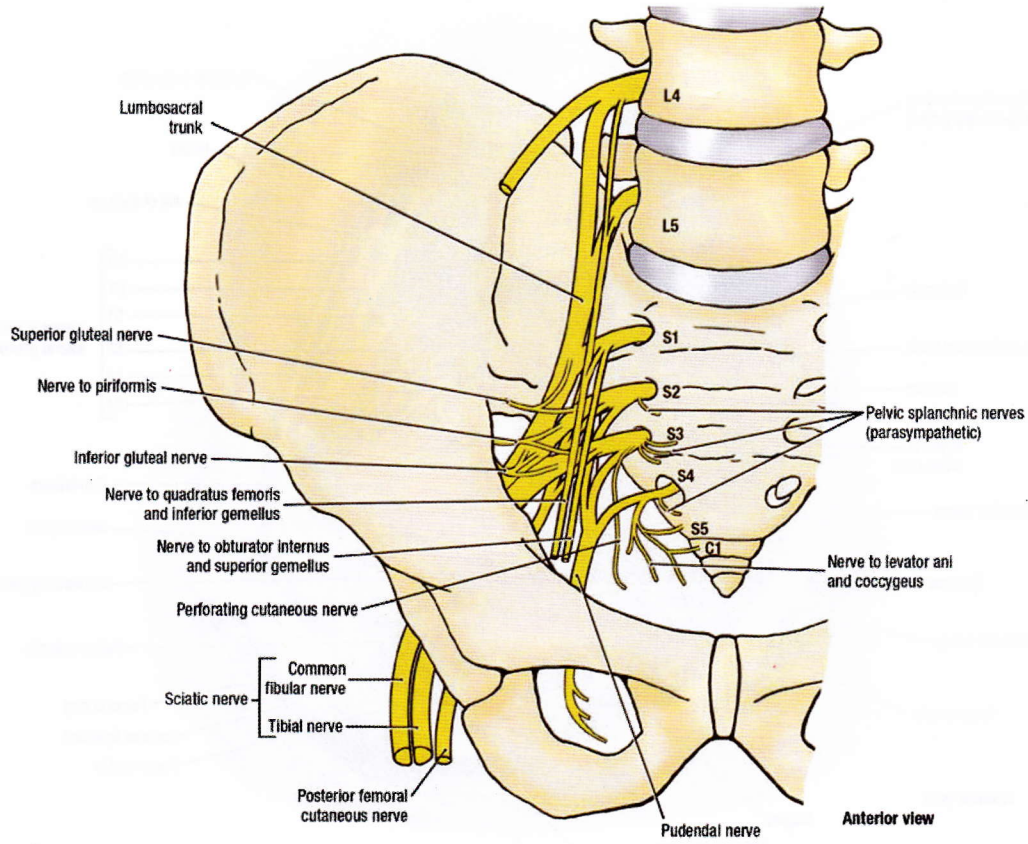
Branches From The Dorsal Divisions

- → Nerve to piriformis (S1 & S2).
- → Superior gluteal nerve (L4, L5 & S1).
- → Perforating cutaneous nerve (S2 & S3).

Branches that arise from both Ventral & Dorsal Divisions

- → Sciatic nerve: divides into:
  - Tibial nerve (medial popliteal) from ventral divisions of L4, L5, S1, S2 & S3.
  - Common peroneal (lateral popliteal) from dorsal divisions of L4, L5, S1 & S2.
- → Posterior femoral cutaneous nerve from the ventral divisions of S2, S3 & dorsal divisions of S1 & S2.

Sciatic Nerve



COURSE:

- Largest branch of sacral plexus (L4, L5, S1, S2 & S3).
- Leaves the pelvis through greater sciatic foramen below the piriformis & descends in the gluteal region.
- It extends from the inferior border of the piriformis muscle to the lower ⅓ of the thigh.
- It is crossed obliquely by the long head of biceps femoris muscle.
- It ends by dividing into common peroneal (lateral politeal) & tibial (medial popliteal) nerves.

N.B. ***Sometimes the nerve divides in the pelvis & tibial nerve takes the same course of the sciatic nerve.***

BRANCHES:

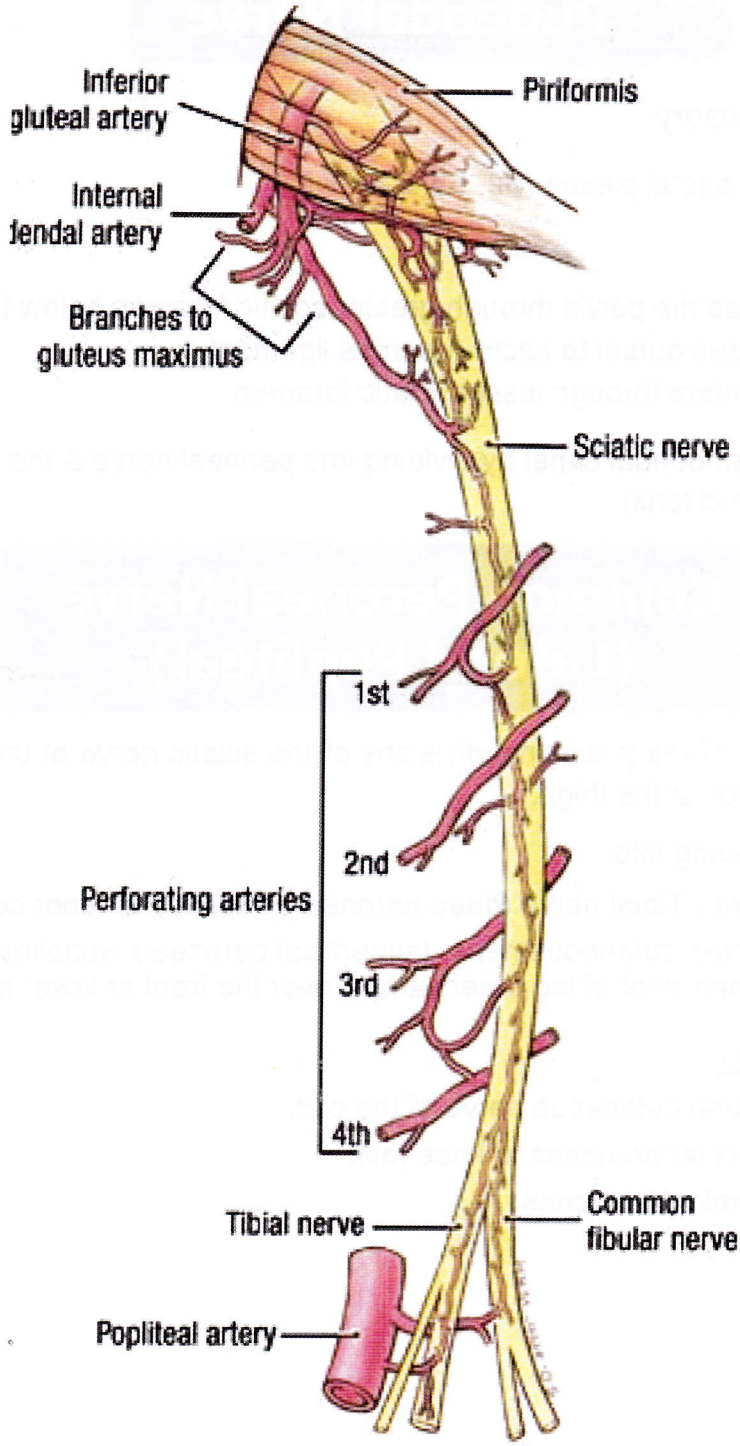
➢ ***Muscular branches to:***

a. Biceps femoris
b. Semitendinosus
c. Semimembranosus
d. Ischial part of adductor magnus

➢ ***2 terminal divisions***

N.B.

- The nerve is likely to be injured in posterior hip dislocation. MCQ
- Injury of the nerve below mid-thigh → intact hamstring muscles.
- it has blood supply from gluteal A.


Inferior gluteal artery
Piriformis
Internal iliac artery
Branches to gluteus maximus
Sciatic nerve
1st
2nd
Perforating arteries
3rd
4th
Tibial nerve
Common fibular nerve
Popliteal artery

Pudendal Nerve

It is purely sensory.

ORIGIN: from sacral plexus (S2, S3 & S4).

COURSE:

- Leaves the pelvis through greater sciatic foramen below the piriformis.
- Crosses dorsal to sacro-tuberous ligament.
- Re-enters through lesser sciatic foramen.

ENDS: In the pudendal canal by dividing into perineal nerve & the dorsal nerve of the penis (or the clitoris).

Common Peroneal Nerve (Lateral Popliteal)

ORIGIN: One of the 2 terminal divisions of the sciatic nerve at the middle of the back of the thigh.

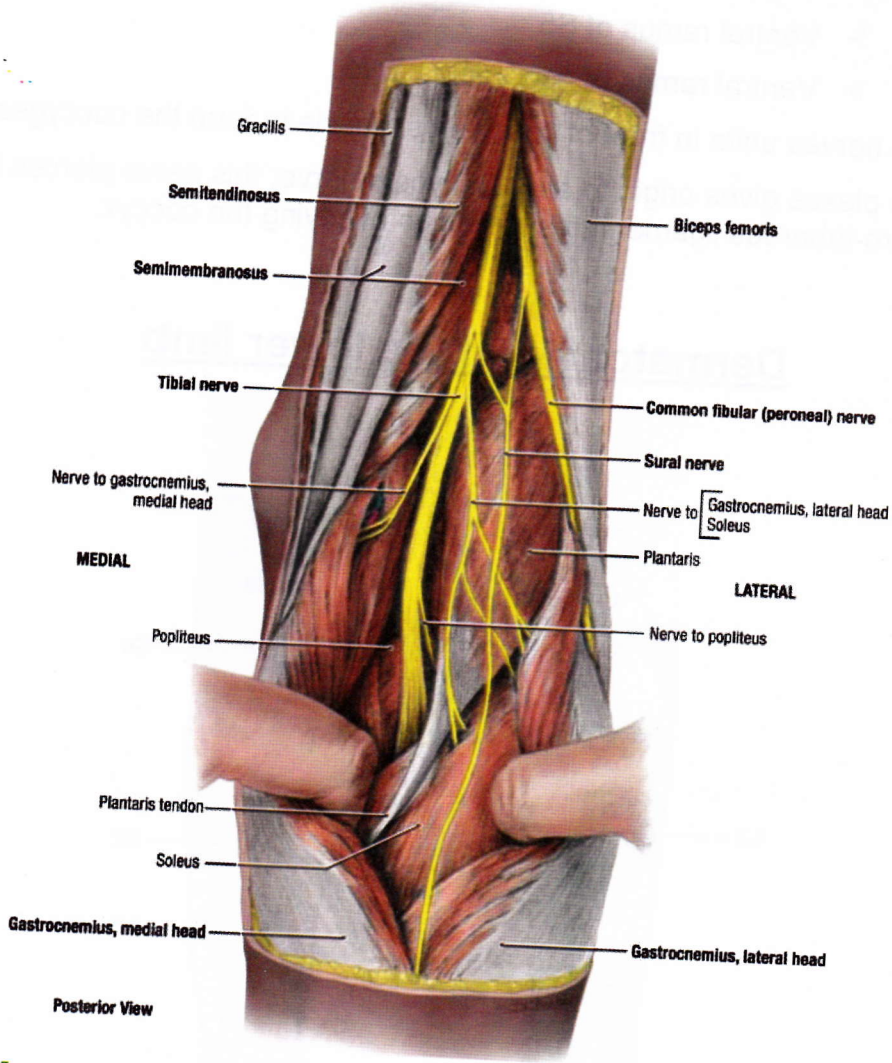
ENDS: By dividing into:

1. Anterior Tibial nerve (deep peroneal): supplies anterior compartment of leg.
2. Musculo-cutaneous nerve (superficial peroneal): supplies lateral compartment of leg & sensations over the front of lower part of leg.

BRANCHES:

1. Lateral cutaneous nerve of the calf.
2. Articular branches to knee joint..
3. Terminal branches.

Tibial Nerve (Medial Popliteal)



ORIGIN: The larger of the 2 terminal divisions of the sciatic nerve.

ENDS: At distal border of popliteus where it continues as posterior tibial nerve.

BRANCHES:

1. Sural nerve.
2. Muscular branches to: gastrocnemius, soleus, plantaris and popliteus.
3. Articular branches to knee joint.

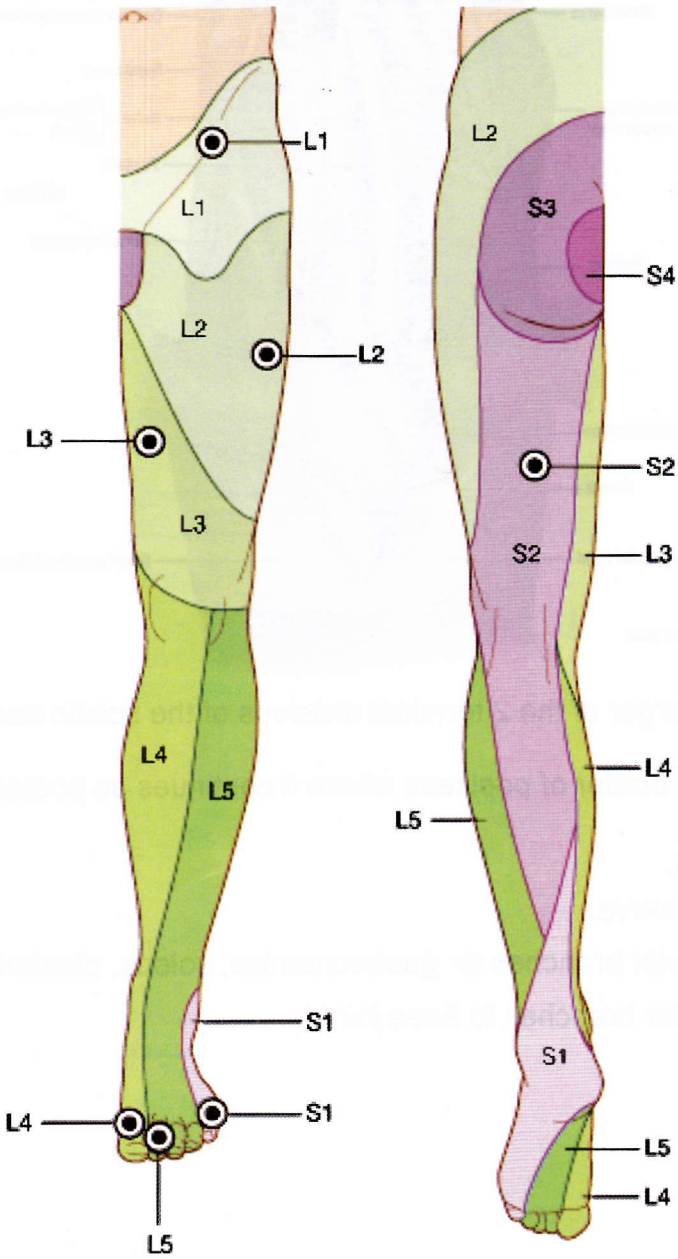
Coccygeal Plexus

It formed by :

- Ventral ramus of S4.
- Ventral ramus of S5.
- Ventral ramus of coccygeal nerve.

- The nerves unite in front of coccygeus muscle to form the coccygeal plexus.
- The plexus gives origin to ano-coccygeal nerve; this nerve pierces the sacro-tuberous ligament to supply skin overlying the coccyx.

Dermatomes of the lower limb



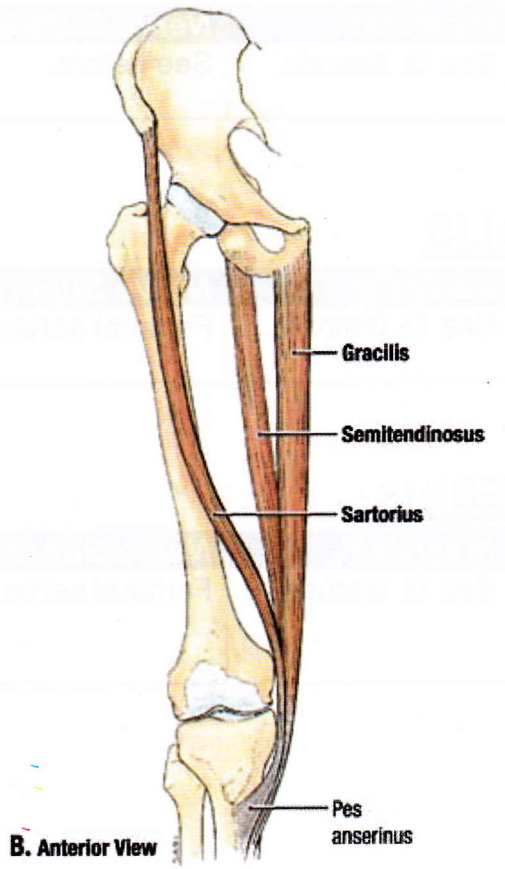
MUSCLES OF LOWER LIMB

Front of the Thigh

- **All are extensors of knee & supplied by femoral nerve.**
- **The ilio-psoas flex the hip.**

SARTORIUS

Origin	*Insertion*	*Nerve Supply*	*Action*
Anterior superior iliac spine (A.S.I.S.).	Upper part of the medial surface of the tibia (S.G.S.T.).	Femoral nerve.	**Tailor's position** (cross leg position): *flexion of both hip & knee joints.* *Abduction & lateral rotation of thigh & medial rotation of leg.*



B. Anterior View

QUADRICEPS FEMORIS (RECTUS FEMORIS & 3 VASTI)

MCQ

- ***Insertion:*** *Patella (by common tendon which extends as patellar ligament).*
- ***Nerve supply:*** *Femoral nerve.*
- ***Action:*** *the whole muscle is the main extensor of the knee.*
  The rectus femoris is also flexor of hip joint.

RECTUS FEMORIS

Origin	Insertion	Nerve Supply	Action
Straight head: anterior inferior iliac spine. *Reflected head:* groove above acetabulum.	See Before	See Before	Flexion of the hip & extension of the knee.

VASTUS MEDIALIS

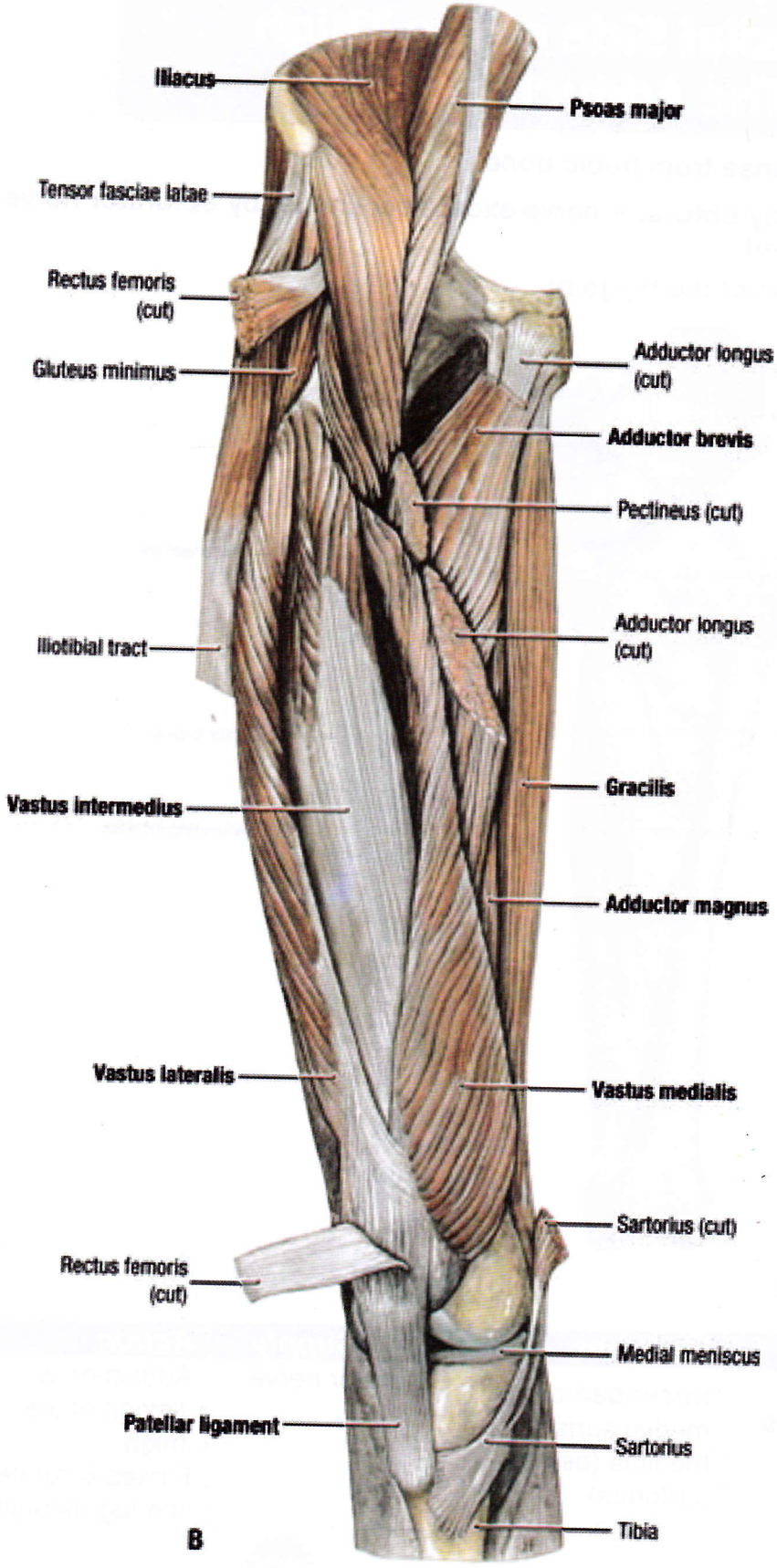
Origin	Insertion	Nerve Supply	Action
Medial lip of the linea aspra.	See Q. femoris.	See before.	Extension of the knee.

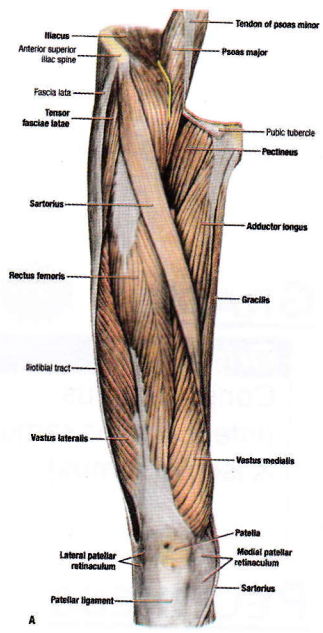
VASTUS LATERALIS

Origin	Insertion	Nerve Supply	Action
Lateral lip of the linea aspra.	See Q. femoris.	Femoral nerve.	Extension of the knee.

VASTUS INTERMEDIUS

Origin	Insertion	Nerve Supply	Action
Upper ⅔ of the anterior & lateral surface of the femur.	See Q. femoris.	Femoral nerve.	Extension of the knee.

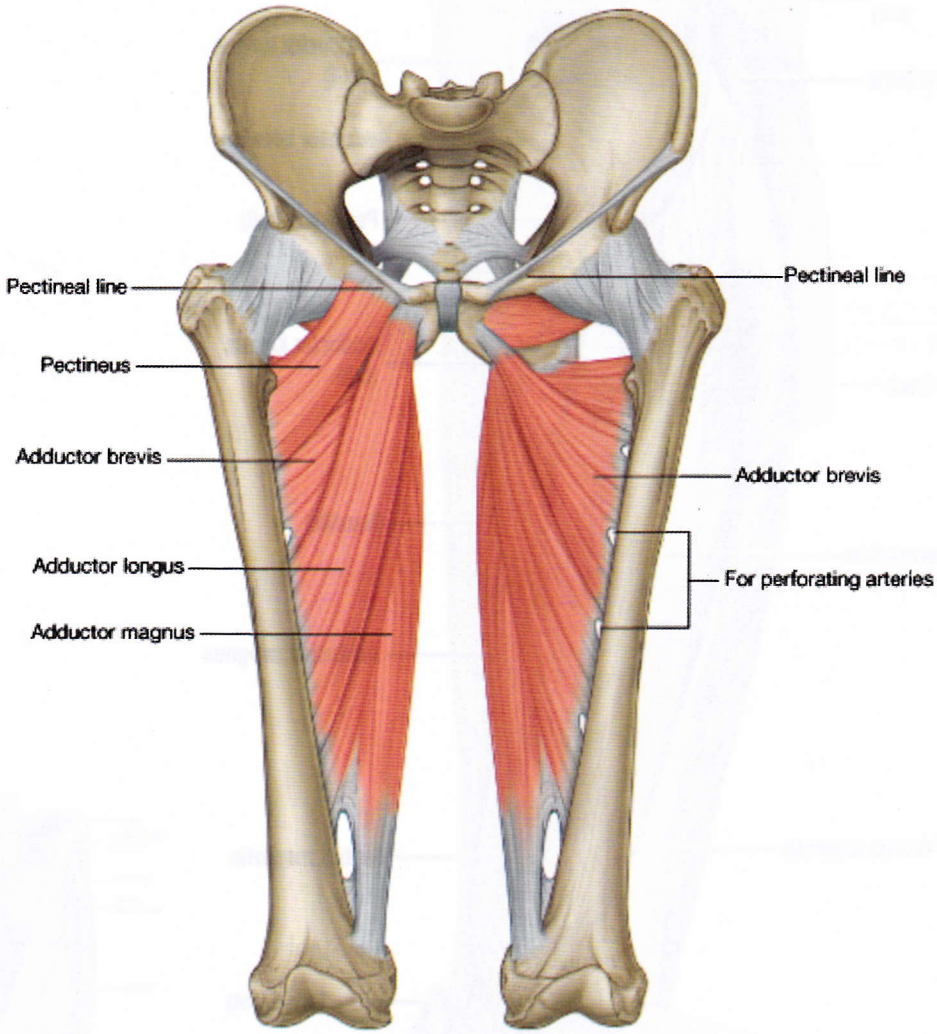




Anterior Views

Medial Side of the Thigh (The Adductor Group)

- These muscles arise from pubic bone.
- All are supplied by obturator nerve except pectineus (by obturator nerve and femoral nerve).
- Action: adduction of the hip joint.



GRACILIS MCQ

Origin	Insertion	Nerve Supply	Action
Conjoint ramus (inferior pubic ramus & ischial ramus).	Upper part of the medial surface of the tibia (behind sartorius).	Obturator nerve.	-Adduction & flexion of the thigh. Flexes & rotate the leg medially

PECTINEUS MCQ

Origin	Insertion	Nerve Supply	Action
Pectineal surface of pubis.	Below lesser trochanter.	Obturator nerve & femoral nerve.	Adduction of the hip joint & flexion of the thigh.

ADDUCTOR BREVIS

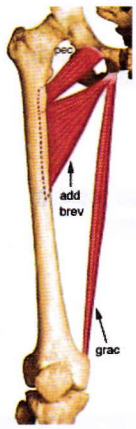
Origin	Insertion	Nerve Supply	Action
Body & inferior ramus of the pubis below adductor longus.	Linea aspra.	Obturator nerve.	Adduction of the hip joint.

ADDUCTOR LONGUS

Origin	Insertion	Nerve Supply	Action
Front of the body of the pubis just below pubic tubercle (rounded tendon).	Linea aspra.	obturator nerve.	Adduction of the hip joint.

ADDUCTOR MAGNUS

Origin	Insertion	Nerve Supply	Action
Adductor part: conjoint ramus (inferior pubic ramus & ischial ramus). *Hamstring part:* lower lateral part of the ischial tuberosity.	Linea aspra. *Adductor tubercle.*	Obturator nerve. Sciatic nerve.	Adduction. Extension of the hip joint.



Adductor brevis

Adductor longus

Adductor magnus

Surgical importance:

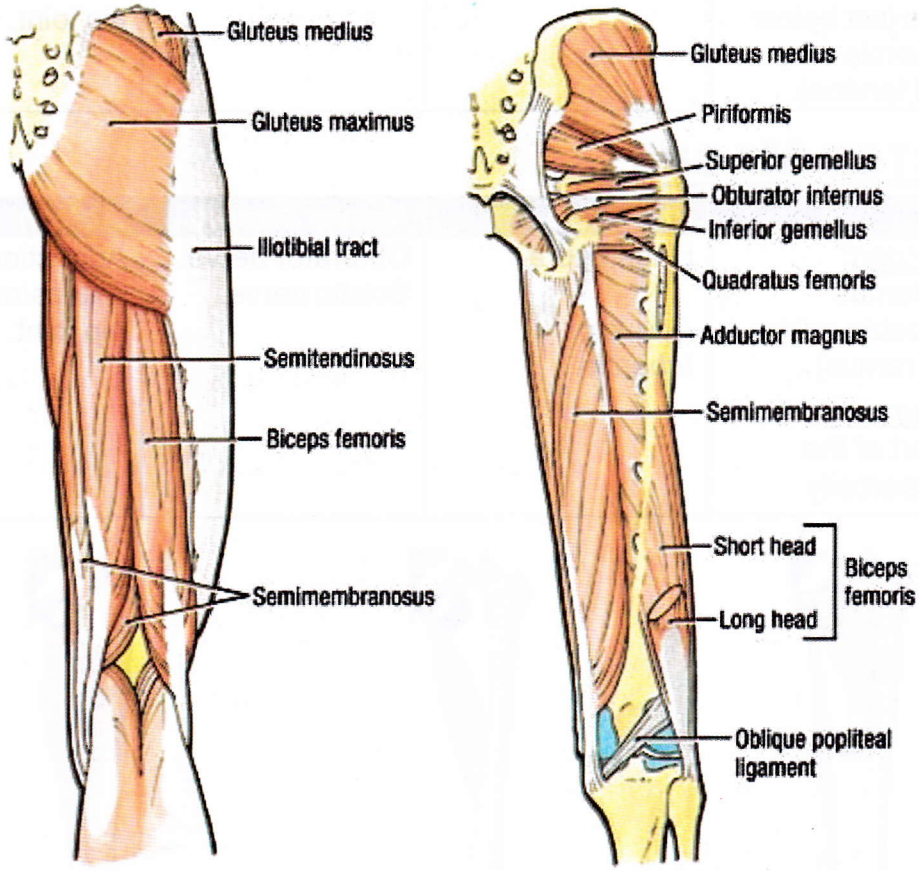
Spasm of adductors of thigh (spastic paraplegia) can be relieved by surgical division of obturator nerve.

Back of the Thigh (Hamstring muscles)

Common features:

MCQ

- They arise primarily from the ischial tuberosity.
- They are supplied by the sciatic nerve.
- They flex the leg (knee) and extend the thigh (hip).



SEMITENDINOSUS

Origin	Insertion	Nerve Supply	Action
Lower medial part of the upper area of ischial tuberosity (with long head of the biceps).	Surface of the tibia (behind gracilis).	Sciatic nerve.	Flexion of the leg (knee) and extension of the thigh (hip).

SEMIMEMBRANOSUS

Origin	Insertion	Nerve Supply	Action
Upper lateral part of the upper area of ischial tuberosity	S.G.S.T. tibia	Sciatic nerve.	Flexion of the leg (knee) and extension of the thigh (hip).

BICEPS FEMORIS

Origin	Insertion	Nerve Supply	Action
Long head: with semitendinosus. Short head: linea aspra.	Head of fibula.	Sciatic nerve.	Flexion of the leg (knee) and extension of the thigh (hip).

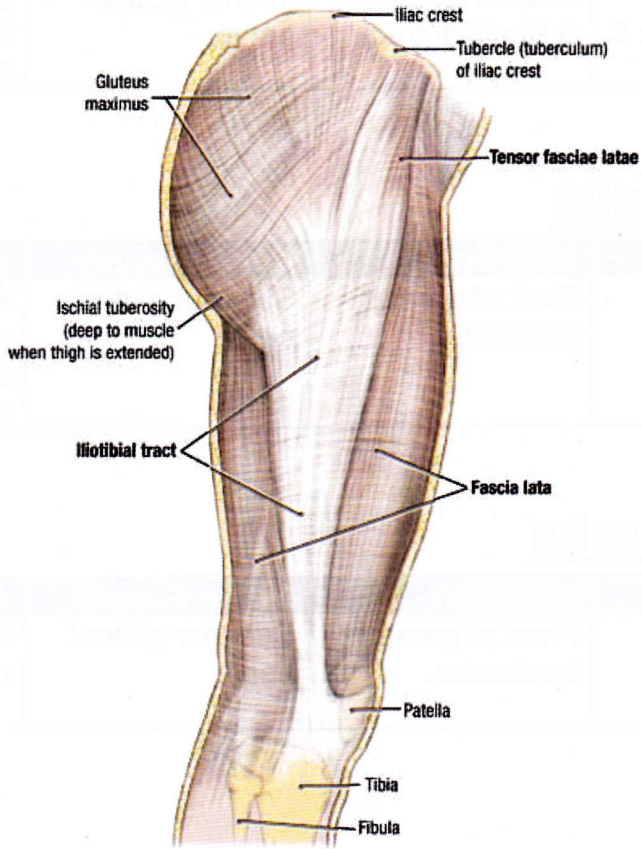
Surgical importance:

Injury of lateral popliteal nerve should be avoided as it is closely related to medial border of biceps tendon.

Gluteal Region

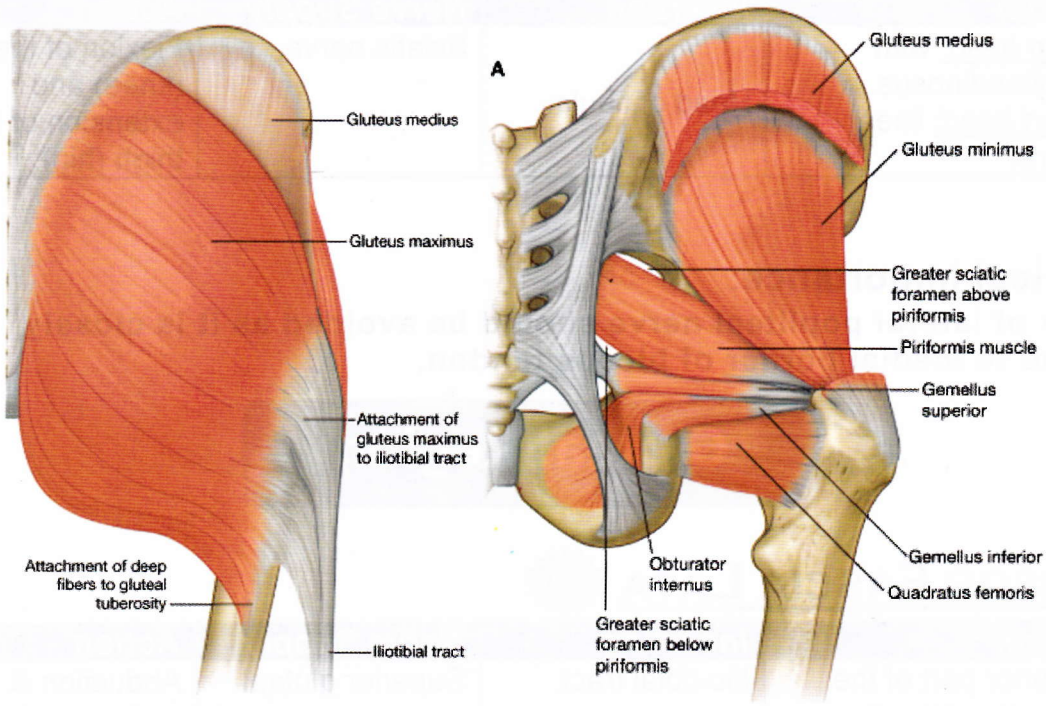
TENSOR FASCIA LATA MCQ

Origin	Insertion	Nerve Supply	Action
Anterior part of the outer lip of the iliac crest.	Ilio-tibial tract.	Superior gluteal nerve.	Abduction & maintains the extended knee.



B. Lateral View

3 GLUTEAL MUSCLES MCQ



GLUTEUS MAXIMUS

Origin	Insertion	Nerve Supply	Action
Hip bone behind the posterior gluteal line & back of the sacrum.	Gluteal tuberosity & ilio-tibial tract.	Inferior gluteal nerve.	Extension of the hip joint & rotate the thigh laterally.

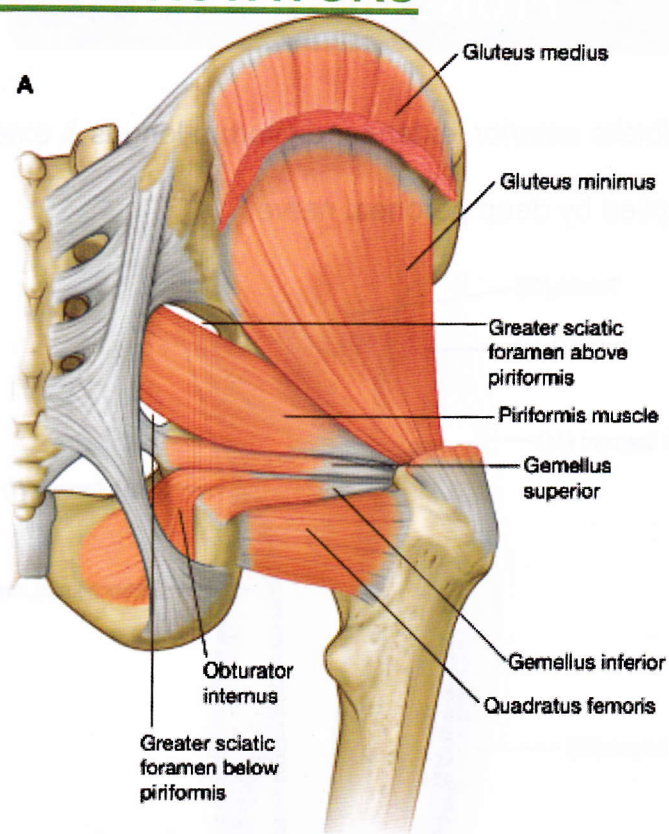
GLUTEUS MEDIUS

Origin	Insertion	Nerve Supply	Action
Hip bone between anterior & posterior gluteal lines.	Back of greater trochanter.	Superior gluteal nerve.	Abduction, medial rotation of the hip & standing on one limb.

GLUTEUS MINIMUS

Origin	Insertion	Nerve Supply	Action
Hip bone between anterior & inferior gluteal lines.	Front of greater trochanter.	Superior gluteal nerve.	Same as gluteus medius.

6 Hip Lateral Rotators



Obturator Externus

Origin	Insertion	Nerve Supply	Action
Outer surface of the obturator foramen & membrane.	Trochanteric fossa of the femur.	Obturator nerve.	Lateral rotation of the thigh.

Piriformis

Origin	Insertion	Nerve Supply	Action
Anterior surface of the middle 3 pieces of sacrum	Upper border of the greater trochanter.	S1 & S2.	Lateral rotation of the thigh.

Obturator Internus (See above)

Superior & Inferior Gemelli

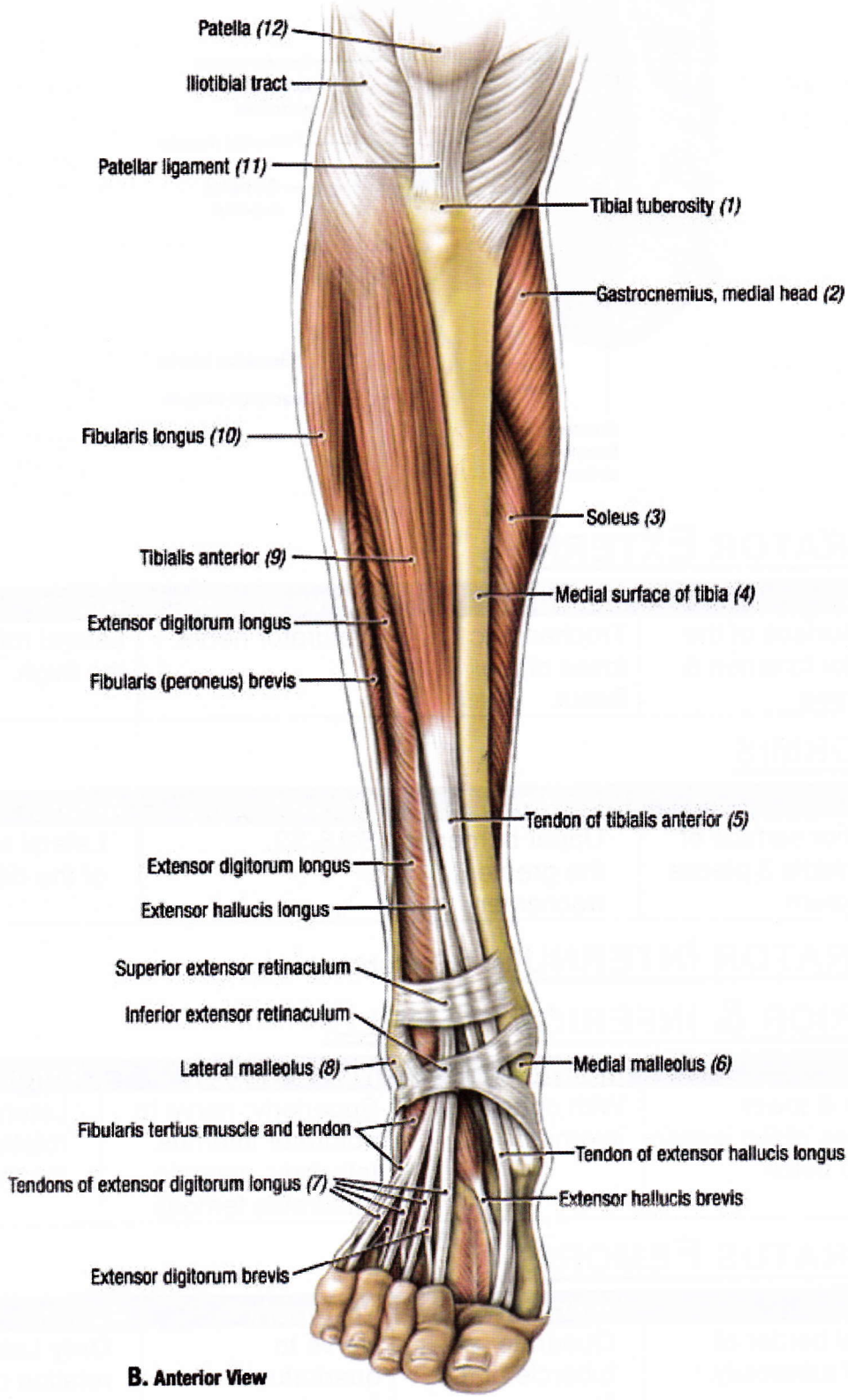
Origin	Insertion	Nerve Supply	Action
Upper & lower margins of the lesser sciatic notch.	With obturator internus.	Superiorly: nerve to obturator internus. Inferiorly: nerve to quadratus femoris.	Lateral rotation of the thigh.

Quadratus Femoris

Origin	Insertion	N Supply	Action
Lateral border of ischial tuberosity.	Quadrate tubercle of the femur.	Nerve to quadratus femoris	**Only** Lateral rotation of the thigh.

Front of the Leg

- <u>These include:</u> tibialis anterior, extensor digitorum longus & extensor hallucis longus.
- They are all supplied by deep peroneal nerve.



B. Anterior View

TIBIALIS ANTERIOR

Origin	Insertion	Nerve Supply	Action
Upper ⅔ of the lateral surface of the tibia.	Medial cuneiform.	Anterior tibial nerve.	Dorsiflexion & inversion of the foot.

EXTENSOR DIGITORUM LONGUS

Origin	Insertion	Nerve Supply	Action
Upper ¾ of anterior surface of the fibula.	Extensor expansion into middle & distal phalanges of lateral 4 toes.	Anterior tibial nerve.	Dorsiflexion of the foot & extension of lateral 4 toes.

EXTENSOR HALLUCIS LONGUS

Origin	Insertion	Nerve Supply	Action
Middle 2/4 of the anterior surface of fibula.	Base of the distal phalanx of the big toe.	Anterior tibial nerve.	Dorsiflexion of the foot & extension of the big toe.

PERONEUS TERTIUS

Origin	Insertion	Nerve Supply	Action
Lower ¼ of the anterior surface of the fibula.	5th metatarsal bone.	Anterior tibial nerve.	Dorsiflexion & eversion of the foot.

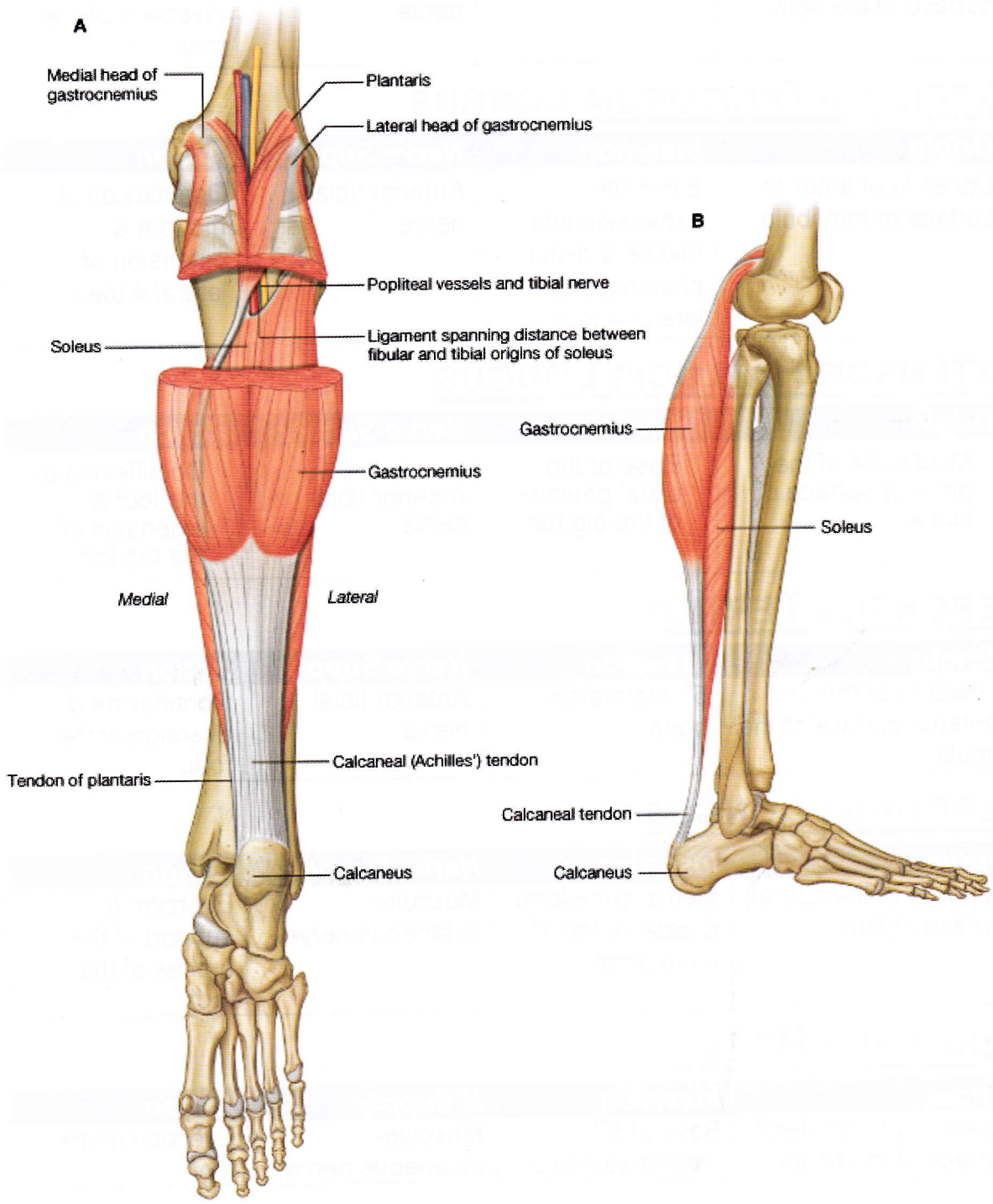
PERONEUS LONGUS

Origin	Insertion	Nerve Supply	Action
Upper ⅔ of the lateral surface of fibula.	Medial cuneiform & base of the 1st metatarsal.	Musculo-cutaneous nerve.	Eversion & support of the arches of the foot.

PERONEUS BREVIS

Origin	Insertion	N Supply	Action
Lower ⅔ of the lateral surface of the fibula.	Base of 5th metatarsal bone	Musculo-cutaneous nerve.	Eversion of the foot.

Back of the Leg (Superficial Group)



GASTROCNEMIUS

Origin	Insertion	Nerve Supply	Action
Medial head: popliteal surface of the femur above medial condyle. Lateral head: lateral epicondyle of the femur.	Tendo-achilis attached to mid-back of calcaneus.	Medial popliteal nerve.	Flexion of the knee & plantar flexion of the ankle.

MCQ SOLEUS: (*deep to gastrocnemius*)

Origin	Insertion	Nerve Supply	Action
Soleal line of tibia & upper ⅓ of the back of the fibula.	Tendo-achilis.	Medial popliteal & tibial nerves.	Plantar flexion of the ankle.

SURGICAL IMPORTANCE:

- Soleus contains a large valveless venous plexus (peripheral heart), which is a common site for DVT.
- Soleus has double nerve supply, so in treatment of intermittent claudication, we should cut both nerves.
- Tibial vessels & nerve lies deep to it.

PLANTARIS

Origin	Insertion	Nerve Supply	Action
Popliteal surface of femur above the lateral condyle.	Posterior surface of calcaneus.	Medial popliteal nerve.	Flexion of the knee & plantar flexion of the foot.

(Deep Group)

POPLITEUS

Origin	Insertion	Nerve Supply	Action
Popliteal groove of the femur (intra-capsular inside knee joint).	Back of the tibia above soleal line.	Medial popliteal nerve.	Flexion & medial rotation which accompanies flexion *(unlocking of knee joint).*

TIBIALIS POSTERIOR

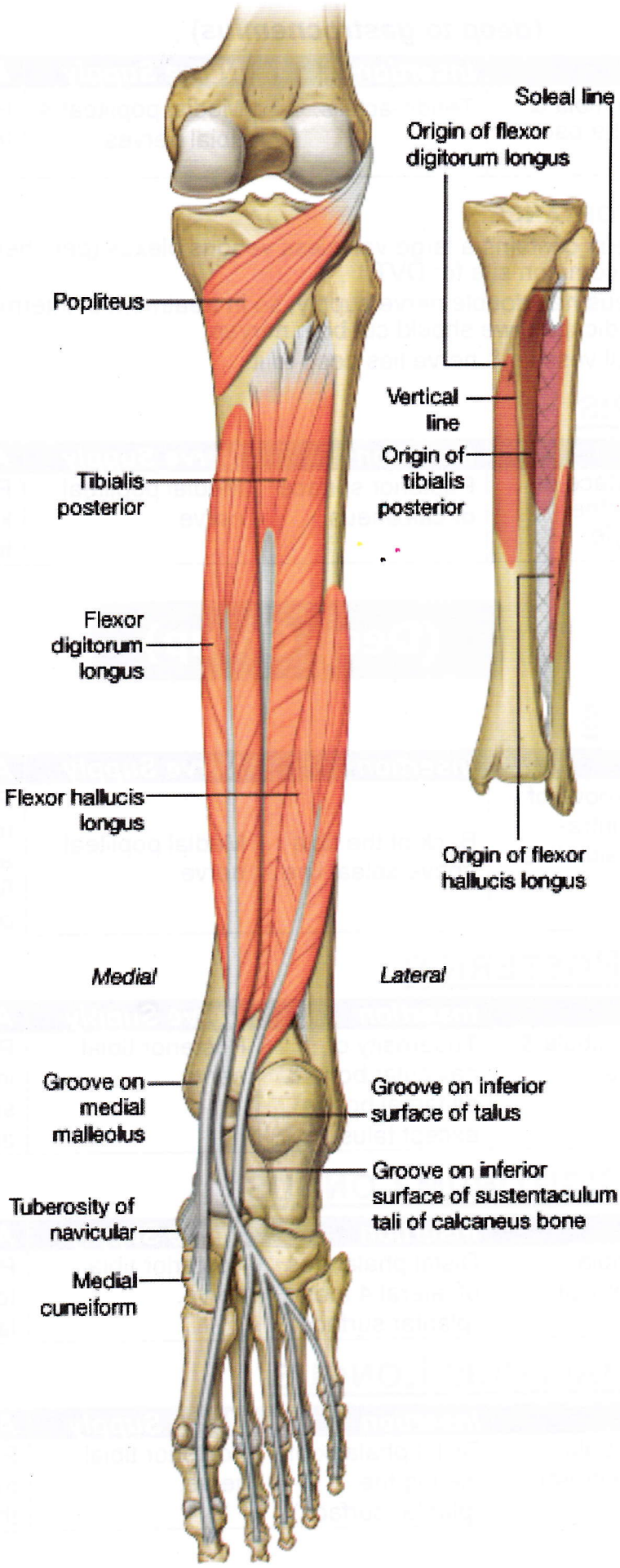
Origin	Insertion	Nerve Supply	Action
Back of tibia, fibula & inter-osseous membrane.	Tuberosity of navicular bone & all tarsal bones except talus.	Posterior tibial nerve.	Plantar flexion & inversion & support of arches of foot.

FLEXOR DIGITORUM LONGUS

Origin	Insertion	Nerve Supply	Action
Back of the tibia (medial to vertical line).	Distal phalanges of lateral 4 toes (plantar surface).	Posterior tibial nerve.	Plantar flexion of foot & flexion of lateral 4 fingers.

FLEXOR HALLUCIS LONGUS

Origin	Insertion	Nerve Supply	Action
Back of the fibula (lateral to the crest).	Distal phalanx of the big toe (plantar surface).	Posterior tibial nerve.	Plantar flexion of foot & flexion of the big toe.


Soleal line
Origin of flexor digitorum longus
Popliteus
Vertical line
Origin of tibialis posterior
Tibialis posterior
Flexor digitorum longus
Flexor hallucis longus
Origin of flexor hallucis longus
Medial
Lateral
Groove on medial malleolus
Groove on inferior surface of talus
Groove on inferior surface of sustentaculum tali of calcaneus bone
Tuberosity of navicular
Medial cuneiform